INSTALLATION RESTORATION PROGRAM

OHIO AIR NATIONAL GUARD
178th FIGHTER GROUP
SPRINGFIELD-BECKLEY MUNICIPAL AIRPORT
SPRINGFIELD, OHIO

APPENDICES
VOLUME II

FINAL

July 1995

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Site Investigation Report, Ohio Air National Guard, 178 Fighter Group, Springfield-Beckley Municipal Airport, Springfield, Ohio, Text. This is the third volume of a three volume site investigation report. Five sites (Site 1 - Fire Training Area No. 1, Site 2 - Fire Training Area No. 2, Site 3 - Leach Field, Site 4 - POL Storage Area, and Site 5 - Ramp Drainage Ditch) were investigated under the Installation Restoration Program. Soil and groundwater samples were collected and analyzed. No further action was recommended for any of the five sites under current land use.

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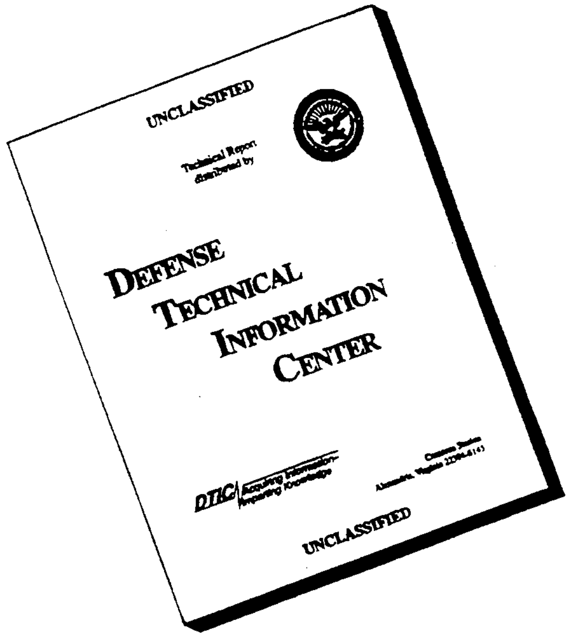

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APPENDIX H

Risk Assessment Tables and Figures

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Table H-1. Chemicals of Potential Concern, Summary Statistics, and Exposure Point Concentrations for Soils - Site 2

178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Total N	Detect	% Detect	NDetect Min	NDetect Max	Detect Min	Detect Max	Mean	MEC	Stand Dev	UCL	REC
Summary Statistics													
Run Time : 9:22:06													
Run Date : 08/2/93													
Site : 2 (s)													
Diesel Fuel	mg/kg	6	2	33	3	21	3	90.75	20.71	20.71	34.51	49.1	49.1
Heavy Oil	mg/kg	6	6	100	0	0	10	322.5	98.92	98.92	112.6	191.5	191.5
Antimony	mg/kg	6	3	50	0.1	0.11	0.43	0.64	0.2983	0.2983	0.2785	0.5274	0.5274
Arsenic	mg/kg	6	6	100	0	0	3.6	21.5	9.783	9.783	6.262	14.93	14.93
Beryllium	mg/kg	6	4	67	0.23	0.27	0.3	0.72	0.3517	0.3517	0.2327	0.5431	0.5431
Cadmium (food)	mg/kg	6	4	67	0.59	0.62	0.38	1.7	0.7458	0.7458	0.5776	1.221	1.221
Chromium (III)	mg/kg	6	6	100	0	0	6.8	24.3	13.08	13.08	7.293	19.08	19.08
Copper	mg/kg	6	6	100	0	0	7.3	21	15.2	15.2	5.826	19.99	19.99
Lead	mg/kg	6	6	100	0	0	12.4	130	33.73	33.73	47.23	72.59	72.59
Mercury	mg/kg	6	2	33	0.05	0.12	0.06	0.1325	0.0546	0.0546	0.0419	0.089	0.089
Nickel	mg/kg	6	6	100	0	0	6.3	24.5	14.19	14.19	6.54	19.57	19.57
Thallium	mg/kg	6	4	67	0.23	0.25	0.205	0.29	0.1992	0.1992	0.0678	0.2549	0.2549
Zinc	mg/kg	6	6	100	0	0	22.6	164.3	64.88	64.88	50.7	106.6	106.6
Acetone	mg/kg*	6	2	33	0.011	0.013	0.026	0.143	0.032	0.032	0.055	0.0772	0.0772
Anthracene	mg/kg*	6	1	17	0.37	0.53	0.5875	0.5875	0.2696	0.2696	0.1588	0.4002	0.4002
Benzo(a)anthracene	mg/kg*	6	3	50	0.37	0.42	0.33	4.65	0.9817	0.9817	1.798	2.461	2.461
Benzo(a)pyrene	mg/kg*	6	4	67	0.37	0.42	0.045	7.59	1.458	1.458	3.006	3.932	3.932
Benzo(b)fluoranthene	mg/kg*	6	6	100	0	0	0.058	12.68	2.428	2.428	5.034	6.569	6.569
Benzo(g,h,i)perylene	mg/kg*	6	3	50	0.37	0.42	0.3	5.11	1.057	1.057	1.987	2.691	2.691
Benzo(k)fluoranthene	mg/kg*	6	3	50	0.37	0.42	0.29	7.14	1.398	1.398	2.814	3.713	3.713
2-Butanone	mg/kg*	6	2	33	0.011	0.013	0.009	0.0325	0.0108	0.0108	0.0107	0.0196	0.0196
Carbazole	mg/kg*	6	2	33	0.37	0.53	0.17	2.685	0.6167	0.6167	1.014	1.451	1.451
Carbon Disulfide	mg/kg*	6	1	17	0.011	0.018	0.004	0.004	0.006	0.004 *	0.0017	0.0074	0.004 *
Chrysene	mg/kg*	6	4	67	0.37	0.42	0.083	11.19	2.147	2.147	4.433	5.794	5.794
Fluoranthene	mg/kg*	6	6	100	0	0	0.053	18.3	3.385	3.385	7.317	9.405	9.405
Indeno(1,2,3-cd)pyrene	mg/kg*	6	3	50	0.37	0.42	0.33	7.125	1.419	1.419	2.798	3.721	3.721
Phenanthrene	mg/kg*	6	4	67	0.37	0.42	0.054	11.18	2.06	2.06	4.47	5.737	5.737
Pyrene	mg/kg*	6	6	100	0	0	0.049	14.77	2.778	2.778	5.887	7.621	7.621

Samples included in data set

Sample	Lab #	Depth to	Depth to	Site	Matrix	Depth Class.
SD2-1	95268	0	0.5	2	SOIL	s
SD2-2	95270	0	0.5	2	SOIL	s
SD2-3	9551	0	0.5	2	SOIL	s
SD2-4	9552	0	0.5	2	SOIL	s
SD2-5	9553	0	0.5	2	SOIL	s
SD2-6	9554	0	0.5	2	SOIL	s

Parameter	Units	Total N	Detect	% Detect	NDetect Min	NDetect Max	Detect Min	Detect Max	Mean	MEC	Stand Dev	UCL	REC
Summary Statistics													
Run Time : 10:30:47													
Run Date : 07/29/93													
Site : 2 (d)													
Gasoline	mg/kg	2	1	50	0.05	0.05	6.8	6.8	3.413	3.413	4.791	24.8	6.8 *
Diesel Fuel	mg/kg	8	7	88	2	2	4	750	241.8	241.8	324.9	459.4	459.4
Heavy Oil	mg/kg	8	4	50	2	2	7	25	7.25	7.25	8.515	12.95	12.95

Table H-1. Chemicals of Potential Concern, Summary Statistics, and Exposure Point Concentrations for Soils - Site 2 (continued)

178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Total N	Detect	% Detect	NDetect Min	NDetect Max	Detect Min	Detect Max	Mean	MEC		Stand Dev	UCL	REC	
Summary Statistics															
Antimony	mg/kg	8	4	50	0.1	0.2	0.19	0.24	0.145	0.145		0.0756	0.1956	0.1956	
Arsenic	mg/kg	8	8	100	0	0	5.9	10.6	7.95	7.95		1.546	8.985	8.985	
Beryllium	mg/kg	8	6	75	0.29	0.38	0.17	0.32	0.2369	0.2369		0.0666	0.2815	0.2815	
Cadmium (food)	mg/kg	8	1	13	0.19	0.62	1.2	1.2	0.2894	0.2894		0.3783	0.5428	0.5428	
Chromium (III)	mg/kg	8	8	100	0	0	5.2	13.2	8.306	8.306		2.412	9.922	9.922	
Copper	mg/kg	8	8	100	0	0	9.7	16.7	14.01	14.01		2.118	15.43	15.43	
Lead	mg/kg	8	8	100	0	0	7.1	31.8	11.59	11.59		8.381	17.21	17.21	
Nickel	mg/kg	8	8	100	0	0	8.2	20.8	13.98	13.98		4.199	16.79	16.79	
Silver	mg/kg	8	2	25	0.45	2.3	1.5	1.5	0.9619	0.9619		0.4906	1.29	1.29	
Thallium	mg/kg	8	6	75	0.24	0.27	0.08	0.26	0.165	0.165		0.0631	0.2073	0.2073	
Zinc	mg/kg	8	8	100	0	0	36.9	61.5	45.33	45.33		8.297	50.89	50.89	
Acetone	mg/kg*	8	5	63	0.011	1.4	0.005	0.343	0.1634	0.1634		0.2428	0.326	0.326	
Benzene	mg/kg*	8	4	50	0.011	1.4	0.008	0.326	0.1389	0.1389		0.2519	0.3077	0.3077	
2-Butanone	mg/kg*	8	2	25	0.011	1.4	0.014	0.019	0.1387	0.019	*	0.2522	0.3076	0.019	*
Ethylbenzene	mg/kg*	8	3	38	0.011	1.4	0.14	0.385	0.1771	0.1771		0.2495	0.3443	0.3443	
Fluoranthene	mg/kg*	8	2	25	0.33	2.5	0.047	0.2125	0.4149	0.2125	*	0.4734	0.732	0.2125	*
Isophorone	mg/kg*	8	2	25	0.33	0.885	0.66	0.83	0.3516	0.3516		0.2637	0.5282	0.5282	
2-Methylnaphthalene	mg/kg*	8	2	25	0.33	2.5	1.185	3.2	0.8144	0.8144		1.073	1.533	1.533	
4-Methyl-2-pentanone	mg/kg*	8	1	13	0.011	1.4	0.05	0.05	0.1415	0.05	*	0.251	0.3096	0.05	*
Naphthalene	mg/kg*	8	2	25	0.33	2.5	0.415	0.85	0.4244	0.4244		0.4091	0.6984	0.6984	
Pentachlorophenol	mg/kg*	8	1	13	0.8	6.1	0.13	0.13	1.084	0.13	*	1.142	1.849	0.13	*
Phenanthrene	mg/kg*	8	1	13	0.33	2.5	0.2275	0.2275	0.4322	0.2275	*	0.4606	0.7407	0.2275	*
Pyrene	mg/kg*	8	3	38	0.36	2.5	0.034	0.2175	0.3997	0.2175	*	0.4847	0.7244	0.2175	*
Xylenes	mg/kg*	8	4	50	0.011	0.011	0.16	1.4	0.3159	0.3159		0.4833	0.6396	0.6396	
Samples included in data set															
Sample	Lab #	Depth to	Depth to	Site	Matrix	Depth Class.									
SB2-1-1	94799	2	3.5	2	SOIL	d									
SB2-1-4	94800	8	9.5	2	SOIL	d									
SB2-2-1	94666	1.5	3.5	2	SOIL	d									
SB2-2-2	94668	3.5	5	2	SOIL	d									
SB2-3-1	94670	1.5	3.5	2	SOIL	d									
SB2-3-4	94671	7.5	9.5	2	SOIL	d									
SB2-4-1	9541	7	9	2	SOIL	d									
SB2-5-1	9543	8	10	2	SOIL	d									
Merged depths - conservative comparison															
Site : 2															
Diesel Fuel	mg/kg	8	7	88	2	2	4	750	241.8	241.8		324.9	459.4	459.4	
Heavy Oil	mg/kg	6	6	100	0	0	10	322.5	98.92	98.92		112.6	191.5	191.5	
Antimony	mg/kg	6	3	50	0.1	0.11	0.43	0.64	0.2983	0.2983		0.2785	0.5274	0.5274	
Arsenic	mg/kg	6	6	100	0	0	3.6	21.5	9.783	9.783		6.262	14.93	14.93	
Beryllium	mg/kg	6	4	67	0.23	0.27	0.3	0.72	0.3517	0.3517		0.2327	0.5431	0.5431	
Cadmium (food)	mg/kg	6	4	67	0.59	0.62	0.38	1.7	0.7458	0.7458		0.5776	1.221	1.221	
Chromium (III)	mg/kg	6	6	100	0	0	6.8	24.3	13.08	13.08		7.293	19.08	19.08	
Copper	mg/kg	6	6	100	0	0	7.3	21	15.2	15.2		5.826	19.99	19.99	
Lead	mg/kg	6	6	100	0	0	12.4	130	33.73	33.73		47.23	72.59	72.59	
Mercury	mg/kg	6	2	33	0.05	0.12	0.06	0.1325	0.0546	0.0546		0.0419	0.089	0.089	
Nickel	mg/kg	6	6	100	0	0	6.3	24.5	14.19	14.19		6.54	19.57	19.57	
Silver	mg/kg	8	2	25	0.45	2.3	1.5	1.5	0.9619	0.9619		0.4906	1.29	1.29	
Thallium	mg/kg	6	4	67	0.23	0.25	0.205	0.29	0.1992	0.1992		0.0678	0.2549	0.2549	

Table H-1. Chemicals of Potential Concern, Summary Statistics, and Exposure Point Concentrations for Soils - Site 2 (continued)

178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Total N	Detect	% Detect	NDetect Min	NDetect Max	Detect Min	Detect Max	Mean	MEC		Stand Dev	UCL	REC	
Summary Statistics															
Zinc	mg/kg	6	6	100	0	0	22.6	164.3	64.88	64.88		50.7	106.6	106.6	
Acetone	mg/kg*	8	5	63	0.011	1.4	0.005	0.343	0.1634	0.1634		0.2428	0.326	0.326	
Anthracene	mg/kg*	6	1	17	0.37	0.53	0.5875	0.5875	0.2696	0.2696		0.1588	0.4002	0.4002	
Benzene	mg/kg*	8	4	50	0.011	1.4	0.008	0.326	0.1389	0.1389		0.2519	0.3077	0.3077	
Benzo(a)anthracene	mg/kg*	6	3	50	0.37	0.42	0.33	4.65	0.9817	0.9817		1.798	2.461	2.461	
Benzo(a)pyrene	mg/kg*	6	4	67	0.37	0.42	0.045	7.59	1.458	1.458		3.006	3.932	3.932	
Benzo(b)fluoranthene	mg/kg*	6	6	100	0	0	0.058	12.68	2.428	2.428		5.034	6.569	6.569	
Benzo(g,h,i)perylene	mg/kg*	6	3	50	0.37	0.42	0.3	5.11	1.057	1.057		1.987	2.691	2.691	
Benzo(k)fluoranthene	mg/kg*	6	3	50	0.37	0.42	0.29	7.14	1.398	1.398		2.814	3.713	3.713	
2-Butanone	mg/kg*	8	2	25	0.011	1.4	0.014	0.019	0.1387	0.019	*	0.2522	0.3076	0.019	*
Carbazole	mg/kg*	6	2	33	0.37	0.53	0.17	2.685	0.6167	0.6167		1.014	1.451	1.451	
Carbon Disulfide	mg/kg*	6	1	17	0.011	0.018	0.004	0.004	0.006	0.004	*	0.0017	0.0074	0.004	*
Chrysene	mg/kg*	6	4	67	0.37	0.42	0.083	11.19	2.147	2.147		4.433	5.794	5.794	
Ethylbenzene	mg/kg*	8	3	38	0.011	1.4	0.14	0.385	0.1771	0.1771		0.2495	0.3443	0.3443	
Fluoranthene	mg/kg*	6	6	100	0	0	0.053	18.3	3.385	3.385		7.317	9.405	9.405	
Indeno(1,2,3-cd)pyrene	mg/kg*	6	3	50	0.37	0.42	0.33	7.125	1.419	1.419		2.798	3.721	3.721	
Isophorone	mg/kg*	8	2	25	0.33	0.885	0.66	0.83	0.3516	0.3516		0.2637	0.5282	0.5282	
2-Methylnaphthalene	mg/kg*	8	2	25	0.33	2.5	1.185	3.2	0.8144	0.8144		1.073	1.533	1.533	
4-Methyl-2-pentanone	mg/kg*	8	1	13	0.011	1.4	0.05	0.05	0.1415	0.05	*	0.251	0.3096	0.05	*
Naphthalene	mg/kg*	8	2	25	0.33	2.5	0.415	0.85	0.4244	0.4244		0.4091	0.6984	0.6984	
Pentachlorophenol	mg/kg*	8	1	13	0.8	6.1	0.13	0.13	1.084	0.13	*	1.142	1.849	0.13	*
Phenanthrene	mg/kg*	6	4	67	0.37	0.42	0.054	11.18	2.06	2.06		4.47	5.737	5.737	
Pyrene	mg/kg*	6	6	100	0	0	0.049	14.77	2.778	2.778		5.887	7.621	7.621	
Xylenes	mg/kg*	8	4	50	0.011	0.011	0.16	1.4	0.3159	0.3159		0.4833	0.6396	0.6396	

Total N	Total number of samples collected
Detect	Total number of samples in which the analyte was detected
% Detect	Percent of samples in which the analyte was detected
NDetect Min	Minumum Contract Required Limit (CRL)
NDetect Max	Maximum CRL
Detect Min	Minimum detected value
Detect Max	Maximum detected value
MEC	MLE exposure concentration
Stand Dev	Standard deviation
UCL	95% upper confidence limit on the mean
REC	RME exposure concentration
Merged depths	Data set includes both surface and subsurface soils (0 to 10 feet)

Depth for soil samples included in the data set are in units of feet

* (in "Units" column) indicates that sample results were reported in $\mu g/kg$ and have been converted to mg/kg

* (in last column) indicates that the 95% UCL exceeds the maximum value; therefore the maximum value is substituted as the REC instead of the 95% UCL

Table H-2. Chemicals of Potential Concern, Summary Statistics, and Exposure Point Concentrations for Groundwater - Site 2

178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Total N	Detect	% Detect	NDetect Min	NDetect Max	Detect Min	Detect Max	Mean	MEC		Stand Dev	UCL	REC	
Summary Statistics															
Run Time : 9:23:36															
Run Date : 08/2/93															
Site : 2 0															
Diesel Fuel	mg/L	3	3	100	0	0	0.3	0.5	0.4067	0.4067		0.1007	0.5764	0.5	*
Antimony	mg/L*	3	2	67	0.0006	0.0006	0.0019	0.003	0.0017	0.0017		0.0014	0.004	0.003	*
Arsenic	mg/L*	3	3	100	0	0	0.0034	0.078	0.031	0.031		0.0409	0.1	0.078	*
Beryllium	mg/L*	3	3	100	0	0	0.0016	0.0103	0.0054	0.0054		0.0045	0.0129	0.0103	*
Chromium (III)	mg/L*	3	3	100	0	0	0.0999	0.348	0.233	0.233		0.125	0.4438	0.348	*
Copper	mg/L*	3	3	100	0	0	0.0903	0.584	0.3111	0.3111		0.2509	0.7342	0.584	*
Lead	mg/L*	3	3	100	0	0	0.0541	0.197	0.124	0.124		0.0715	0.2446	0.197	*
Nickel	mg/L*	3	3	100	0	0	0.0824	0.562	0.2941	0.2941		0.2447	0.7066	0.562	*
Silver	mg/L*	3	2	67	0.0029	0.0029	0.004	0.0195	0.0083	0.0083		0.0098	0.0248	0.0195	*
Zinc	mg/L*	3	2	67	1.13	1.13	0.536	1.46	0.8537	0.8537		0.5253	1.739	1.46	*
Antimony (d)	mg/L*	2	1	50	0.0009	0.0009	0.0015	0.0015	0.001	0.001		0.0007	0.0043	0.0015	*
Arsenic (d)	mg/L*	2	2	100	0	0	0.0015	0.0021	0.0018	0.0018		0.0004	0.0037	0.0021	*
Zinc (d)	mg/L*	2	1	50	0.0185	0.0185	0.0541	0.0541	0.0317	0.0317		0.0317	0.1733	0.0541	*
Tetrachloroethylene	mg/L*	3	1	33	0.0004	0.0004	0.0002	0.0002	0.0002	0.0002	*	0	0.0002	0.0002	*
Samples included in data set															
Sample	Lab #	Depth to	Depth to	Site	Matrix	Depth Class.									
MW2-1-1	97396			2	WATER										
MW2-1-2	#######			2	WATER										
MW2-2-1	#######			2	WATER										

Total N	Total number of samples collected
Detect	Total number of samples in which the analyte was detected
% Detect	Percent of samples in which the analyte was detected
NDetect Min	Minumum Contract Required Limit (CRL)
NDetect Max	Maximum CRL
Detect Min	Minimum detected value
Detect Max	Maximum detected value
MEC	MLE exposure concentration
Stand Dev	Standard deviation
UCL	95% upper confidence limit on the mean
REC	RME exposure concentration
Merged depths	Data set includes both surface and subsurface soils (0 to 10 feet)

Depth for soil samples included in the data set are in units of feet

* (in "Units" column) indicates that sample results were reported in µg/kg and have been converted to mg/kg

* (in last column) indicates that the 95% UCL exceeds the maximum value; therefore the maximum value is substituted as the REC instead of the 95% UCL

Table H-3. Chemicals of Potential Concern, Summary Statistics, and Exposure Point Concentrations for Soils - Site 3

178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Total N	Detect	% Detect	NDetect Min	NDetect Max	Detect Min	Detect Max	Mean	MEC		Stand Dev	UCL	REC	
Summary Statistics															
Run Time : 9:26:58															
Run Date : 08/2/93															
Site : 3 (s)															
Diesel Fuel	mg/kg	5	2	40	2	3	3	28	6.9	6.9		11.82	18.17	18.17	
Heavy Oil	mg/kg	5	2	40	2	2	29	53	17	17		23.49	39.4	39.4	
Arsenic	mg/kg	5	5	100	0	0	6.1	11	8.77	8.77		1.984	10.66	10.66	
Beryllium	mg/kg	5	5	100	0	0	0.31	0.47	0.382	0.382		0.0661	0.445	0.445	
Cadmium (food)	mg/kg	5	1	20	0.205	0.84	0.28	0.28	0.2045	0.2045		0.1418	0.3397	0.28	*
Chromium (III)	mg/kg	5	5	100	0	0	9.5	27.3	16.4	16.4		6.793	22.88	22.88	
Copper	mg/kg	5	5	100	0	0	15.35	59.2	27.65	27.65		17.96	44.78	44.78	
Lead	mg/kg	5	5	100	0	0	8.1	44.5	25.58	25.58		13.91	38.84	38.84	
Nickel	mg/kg	5	5	100	0	0	14.7	24.3	19.5	19.5		3.592	22.92	22.92	
Thallium	mg/kg	5	1	20	0.14	0.29	0.23	0.23	0.124	0.124		0.0659	0.1868	0.1868	
Zinc	mg/kg	5	5	100	0	0	64.05	312	127.5	127.5		104.4	227.1	227.1	
Acenaphthene	mg/kg*	5	1	20	0.34	0.67	0.035	0.035	0.178	0.035	*	0.1063	0.2793	0.035	*
Anthracene	mg/kg*	5	3	60	0.34	0.67	0.106	0.13	0.1742	0.13	*	0.0928	0.2627	0.13	*
Benzo(a)anthracene	mg/kg*	5	5	100	0	0	0.12	0.8	0.385	0.385		0.3055	0.6763	0.6763	
Benzo(a)pyrene	mg/kg*	5	5	100	0	0	0.12	0.75	0.384	0.384		0.2853	0.656	0.656	
Benzo(b)fluoranthene	mg/kg*	5	5	100	0	0	0.18	1.1	0.555	0.555		0.4236	0.9588	0.9588	
Benzo(g,h,i)perylene	mg/kg*	5	4	80	0.34	0.34	0.135	0.55	0.305	0.305		0.1872	0.4835	0.4835	
Benzo(k)fluoranthene	mg/kg*	5	5	100	0	0	0.064	0.38	0.2348	0.2348		0.1367	0.3651	0.3651	
Carbazole	mg/kg*	5	2	40	0.34	0.67	0.058	0.075	0.1626	0.075	*	0.1102	0.2676	0.075	*
Chrysene	mg/kg*	5	5	100	0	0	0.15	0.9	0.46	0.46		0.3402	0.7843	0.7843	
Fluoranthene	mg/kg*	5	5	100	0	0	0.23	2.1	0.944	0.944		0.8148	1.721	1.721	
Fluorene	mg/kg*	5	2	40	0.34	0.67	0.045	0.051	0.1552	0.051	*	0.1183	0.268	0.051	*
Indeno(1,2,3-cd)pyrene	mg/kg*	5	4	80	0.34	0.34	0.185	0.72	0.371	0.371		0.2494	0.6087	0.6087	
N-nitroso-di-n-propylamine	mg/kg*	5	1	20	0.33	0.67	0.2025	0.2025	0.2095	0.2025	*	0.0716	0.2778	0.2025	*
Phenanthrene	mg/kg*	5	5	100	0	0	0.089	0.78	0.3538	0.3538		0.3008	0.6406	0.6406	
Pyrene	mg/kg*	5	5	100	0	0	0.34	2.4	1.066	1.066		0.9347	1.957	1.957	
Toluene	mg/kg*	5	1	20	0.011	0.011	0.0038	0.0038	0.0052	0.0038	*	0.0008	0.0059	0.0038	*
Samples included in data set															
Sample	Lab #	Depth to	Depth to	Site	Matrix	Depth Class.									
MW3-1-1as	95031	0.5	1.5	3	SOIL	s									
MW3-1-1s	95266	0.5	1.5	3	SOIL	s									
SB3-1-1	94911	0.5	2	3	SOIL	s									
SB3-2-1	94973	0.5	2.5	3	SOIL	s									
SB3-3-1	94976	0.5	2.5	3	SOIL	s									
Parameter	Units	Total N	Detect	% Detect	NDetect Min	NDetect Max	Detect Min	Detect Max	Mean	MEC		Stand Dev	UCL	REC	
Summary Statistics															
Run Time : 10:36:40															
Run Date : 07/29/93															
Site : 3 (d)															
Gasoline	mg/kg	2	2	100	0	0	84	310	197	197		159.8	910.5	310	*
Diesel Fuel	mg/kg	3	3	100	0	0	220	670	473.3	473.3		230.3	861.6	670	*
Heavy Oil	mg/kg	3	3	100	0	0	230	440	353.3	353.3		109.7	538.3	440	*
Antimony	mg/kg	2	1	50	0.1	0.1	0.16	0.16	0.105	0.105		0.0778	0.4523	0.16	*
Arsenic	mg/kg	3	3	100	0	0	3.2	13.4	6.733	6.733		5.777	16.47	13.4	*

Table H-3. Chemicals of Potential Concern, Summary Statistics, and Exposure Point Concentrations for Soils - Site 3 (continued)

178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Total N	Detect	% Detect	NDetect Min	NDetect Max	Detect Min	Detect Max	Mean	MEC		Stand Dev	UCL	REC	
Summary Statistics															
Beryllium	mg/kg	3	1	33	0.16	0.23	0.38	0.38	0.1917	0.1917		0.164	0.4682	0.38	*
Cadmium (food)	mg/kg	3	1	33	0.6	0.61	0.68	0.68	0.4283	0.4283		0.218	0.7958	0.68	*
Chromium (III)	mg/kg	3	3	100	0	0	19.6	35.5	30.07	30.07		9.067	45.35	35.5	*
Copper	mg/kg	3	3	100	0	0	13.5	19.9	16.5	16.5		3.219	21.93	19.9	*
Lead	mg/kg	3	3	100	0	0	11.7	47.4	28.3	28.3		17.98	58.61	47.4	*
Mercury	mg/kg	3	2	67	0.05	0.05	0.05	0.12	0.065	0.065		0.0492	0.148	0.12	*
Nickel	mg/kg	3	3	100	0	0	7.1	14.9	12.23	12.23		4.447	19.73	14.9	*
Selenium	mg/kg	3	1	33	0.13	0.15	0.18	0.18	0.1067	0.1067		0.0637	0.2141	0.18	*
Silver	mg/kg	3	3	100	0	0	2.7	16.4	8.6	8.6		7.045	20.48	16.4	*
Zinc	mg/kg	3	3	100	0	0	45.6	88.4	70.87	70.87		22.42	108.7	88.4	*
Benzo(a)anthracene	mg/kg*	3	2	67	0.37	0.37	0.11	0.2	0.165	0.165		0.0482	0.2463	0.2	*
Benzo(a)pyrene	mg/kg*	3	2	67	0.37	0.37	0.079	0.17	0.1447	0.1447		0.0574	0.2414	0.17	*
Benzo(b)fluoranthene	mg/kg*	3	2	67	0.37	0.37	0.12	0.24	0.1817	0.1817		0.0601	0.2829	0.24	*
Benzo(g,h,i)perylene	mg/kg*	3	1	33	0.37	0.41	0.073	0.073	0.1543	0.073	*	0.0711	0.2743	0.073	*
Benzo(k)fluoranthene	mg/kg*	3	2	67	0.37	0.37	0.037	0.19	0.1373	0.1373		0.0869	0.2839	0.19	*
Carbon Disulfide	mg/kg*	3	1	33	0.013	0.057	0.002	0.002	0.0123	0.002	*	0.0142	0.0362	0.002	*
Chrysene	mg/kg*	3	2	67	0.37	0.37	0.094	0.13	0.1363	0.13	*	0.0458	0.2136	0.13	*
Di-n-octyl phthalate	mg/kg*	3	1	33	0.36	0.37	0.044	0.044	0.1363	0.044	*	0.08	0.2712	0.044	*
Ethylbenzene	mg/kg*	3	2	67	0.057	0.057	0.002	0.01	0.0135	0.01	*	0.0136	0.0364	0.01	*
Fluoranthene	mg/kg*	3	3	100	0	0	0.32	0.78	0.4933	0.4933		0.2501	0.9149	0.78	*
Fluorene	mg/kg*	3	2	67	0.41	0.41	0.056	0.096	0.119	0.096	*	0.0771	0.249	0.096	*
Indeno(1,2,3-cd)pyrene	mg/kg*	3	2	67	0.37	0.37	0.078	0.15	0.1377	0.1377		0.0546	0.2296	0.15	*
2-Methylnaphthalene	mg/kg*	3	3	100	0	0	0.069	0.21	0.1497	0.1497		0.0727	0.2722	0.21	*
Phenanthrene	mg/kg*	3	3	100	0	0	0.19	0.43	0.28	0.28		0.1308	0.5005	0.43	*
Pyrene	mg/kg*	3	2	67	0.37	0.37	0.34	0.38	0.3017	0.3017		0.103	0.4753	0.38	*
Toluene	mg/kg*	3	1	33	0.013	0.057	0.003	0.003	0.0127	0.003	*	0.0138	0.036	0.003	*
Xylenes	mg/kg*	3	3	100	0	0	0.003	0.08	0.0337	0.0337		0.0408	0.1025	0.08	*
Samples included in data set															
Sample	Lab #	Depth to	Depth to	Site	Matrix	Depth Class.									
SB3-2-4	94974	6.5	8	3	SOIL	d									
SB3-4-1	9547	7.5	9	3	SOIL	d									
SB3-5-1	9549	6	8	3	SOIL	d									
Merged depths - conservative comparison															
Site : 3															
Diesel Fuel	mg/kg	3	3	100	0	0	220	670	473.3	473.3		230.3	861.6	670	*
Heavy Oil	mg/kg	3	3	100	0	0	230	440	353.3	353.3		109.7	538.3	440	*
Antimony	mg/kg	2	1	50	0.1	0.1	0.16	0.16	0.105	0.105		0.0778	0.4523	0.16	*
Arsenic	mg/kg	5	5	100	0	0	6.1	11	8.77	8.77		1.984	10.66	10.66	
Beryllium	mg/kg	5	5	100	0	0	0.31	0.47	0.382	0.382		0.0661	0.445	0.445	
Cadmium (food)	mg/kg	3	1	33	0.6	0.61	0.68	0.68	0.4283	0.4283		0.218	0.7958	0.68	*
Chromium (III)	mg/kg	3	3	100	0	0	19.6	35.5	30.07	30.07		9.067	45.35	35.5	*
Copper	mg/kg	5	5	100	0	0	15.35	59.2	27.65	27.65		17.96	44.78	44.78	
Lead	mg/kg	3	3	100	0	0	11.7	47.4	28.3	28.3		17.98	58.61	47.4	*
Mercury	mg/kg	3	2	67	0.05	0.05	0.05	0.12	0.065	0.065		0.0492	0.148	0.12	*
Nickel	mg/kg	5	5	100	0	0	14.7	24.3	19.5	19.5		3.592	22.92	22.92	
Selenium	mg/kg	3	1	33	0.13	0.15	0.18	0.18	0.1067	0.1067		0.0637	0.2141	0.18	*
Silver	mg/kg	3	3	100	0	0	2.7	16.4	8.6	8.6		7.045	20.48	16.4	*
Thallium	mg/kg	5	1	20	0.14	0.29	0.23	0.23	0.124	0.124		0.0659	0.1868	0.1868	
Zinc	mg/kg	5	5	100	0	0	64.05	312	127.5	127.5		104.4	227.1	227.1	

Table H-3. Chemicals of Potential Concern, Summary Statistics, and Exposure Point Concentrations for Soils - Site 3 (continued)

178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Total N	Detect	% Detect	NDetect Min	NDetect Max	Detect Min	Detect Max	Mean	MEC		Stand Dev	UCL	REC	
Summary Statistics															
Acenaphthene	mg/kg*	5	1	20	0.34	0.67	0.035	0.035	0.178	0.035	*	0.1063	0.2793	0.035	*
Anthracene	mg/kg*	5	3	60	0.34	0.67	0.106	0.13	0.1742	0.13	*	0.0928	0.2627	0.13	*
Benzo(a)anthracene	mg/kg*	5	5	100	0	0	0.12	0.8	0.385	0.385		0.3055	0.6763	0.6763	
Benzo(a)pyrene	mg/kg*	5	5	100	0	0	0.12	0.75	0.384	0.384		0.2853	0.656	0.656	
Benzo(b)fluoranthene	mg/kg*	5	5	100	0	0	0.18	1.1	0.555	0.555		0.4236	0.9588	0.9588	
Benzo(g,h,i)perylene	mg/kg*	5	4	80	0.34	0.34	0.135	0.55	0.305	0.305		0.1872	0.4835	0.4835	
Benzo(k)fluoranthene	mg/kg*	5	5	100	0	0	0.064	0.38	0.2348	0.2348		0.1367	0.3651	0.3651	
Carbazole	mg/kg*	5	2	40	0.34	0.67	0.058	0.075	0.1626	0.075	*	0.1102	0.2676	0.075	*
Carbon Disulfide	mg/kg*	3	1	33	0.013	0.057	0.002	0.002	0.0123	0.002	*	0.0142	0.0362	0.002	*
Chrysene	mg/kg*	5	5	100	0	0	0.15	0.9	0.46	0.46		0.3402	0.7843	0.7843	
Di-n-octyl phthalate	mg/kg*	3	1	33	0.36	0.37	0.044	0.044	0.1363	0.044	*	0.08	0.2712	0.044	*
Ethylbenzene	mg/kg*	3	2	67	0.057	0.057	0.002	0.01	0.0135	0.01	*	0.0136	0.0364	0.01	*
Fluoranthene	mg/kg*	5	5	100	0	0	0.23	2.1	0.944	0.944		0.8148	1.721	1.721	
Fluorene	mg/kg*	3	2	67	0.41	0.41	0.056	0.096	0.119	0.096	*	0.0771	0.249	0.096	*
Indeno(1,2,3-cd)pyrene	mg/kg*	5	4	80	0.34	0.34	0.185	0.72	0.371	0.371		0.2494	0.6087	0.6087	
2-Methylnaphthalene	mg/kg*	3	3	100	0	0	0.069	0.21	0.1497	0.1497		0.0727	0.2722	0.21	*
N-nitroso-di-n-propylamine	mg/kg*	5	1	20	0.33	0.67	0.2025	0.2025	0.2095	0.2025	*	0.0716	0.2778	0.2025	*
Phenanthrene	mg/kg*	5	5	100	0	0	0.089	0.78	0.3538	0.3538		0.3008	0.6406	0.6406	
Pyrene	mg/kg*	5	5	100	0	0	0.34	2.4	1.066	1.066		0.9347	1.957	1.957	
Toluene	mg/kg*	5	1	20	0.011	0.011	0.0038	0.0038	0.0052	0.0038	*	0.0008	0.0059	0.0038	*
Xylenes	mg/kg*	3	3	100	0	0	0.003	0.08	0.0337	0.0337		0.0408	0.1025	0.08	*

Total N	Total number of samples collected
Detect	Total number of samples in which the analyte was detected
% Detect	Percent of samples in which the analyte was detected
NDetect Min	Minumum Contract Required Limit (CRL)
NDetect Max	Maximum CRL
Detect Min	Minimum detected value
Detect Max	Maximum detected value
MEC	MLE exposure concentration
Stand Dev	Standard deviation
UCL	95% upper confidence limit on the mean
REC	RME exposure concentration
Merged depths	Data set includes both surface and subsurface soils (0 to 10 feet)

Depth for soil samples included in the data set are in units of feet

* (in "Units" column) indicates that sample results were reported in μg/kg and have been converted to mg/kg

* (in last column) indicates that the 95% UCL exceeds the maximum value; therefore the maximum value is substituted as the REC instead of the 95% UCL

Table H-4. Chemicals of Potential Concern, Summary Statistics, and Exposure Point Concentrations for Groundwater - Site 3
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Total N	Detect	% Detect	NDetect Min	NDetect Max	Detect Min	Detect Max	Mean	MEC		Stand Dev	UCL	REC	
Summary Statistics															
Run Time : 9:27:28															
Run Date : 08/2/93															
Site : 3 0															
Antimony	mg/L*	2	2	100	0	0	0.0013	0.0019	0.0016	0.0016		0.0005	0.0036	0.0019	*
Arsenic	mg/L*	2	2	100	0	0	0.0023	0.0467	0.0245	0.0245		0.0314	0.1645	0.0467	*
Beryllium	mg/L*	2	2	100	0	0	0.0024	0.0026	0.0025	0.0025		0.0002	0.0033	0.0026	*
Cadmium (water)	mg/L*	2	1	50	0.0021	0.0021	0.0038	0.0038	0.0024	0.0024		0.0019	0.0111	0.0038	*
Chromium (III)	mg/L*	2	2	100	0	0	0.068	0.0844	0.0762	0.0762		0.0116	0.1281	0.0844	*
Copper	mg/L*	2	2	100	0	0	0.1118	0.124	0.1179	0.1179		0.0086	0.1564	0.124	*
Lead	mg/L*	2	2	100	0	0	0.0463	0.0624	0.0543	0.0543		0.0114	0.1053	0.0624	*
Nickel	mg/L*	2	2	100	0	0	0.127	0.128	0.1275	0.1275		0.0007	0.1308	0.128	*
Silver	mg/L*	2	1	50	0.0029	0.0029	0.0108	0.0108	0.0061	0.0061		0.0066	0.0356	0.0108	*
Zinc	mg/L*	2	1	50	0.4285	0.4285	0.428	0.428	0.3211	0.3211		0.1511	0.9959	0.428	*
Samples included in data set															
Sample	Lab #	Depth to	Depth to	Site	Matrix	Depth Class.									
MW3-1-1	97311			3	WATER										
MW3-1-2	#######			3	WATER										

Total N	Total number of samples collected
Detect	Total number of samples in which the analyte was detected
% Detect	Percent of samples in which the analyte was detected
NDetect Min	Minumum Contract Required Limit (CRL)
NDetect Max	Maximum CRL
Detect Min	Minimum detected value
Detect Max	Maximum detected value
MEC	MLE exposure concentration
Stand Dev	Standard deviation
UCL	95% upper confidence limit on the mean
REC	RME exposure concentration
Merged depths	Data set includes both surface and subsurface soils (0 to 10 feet)

Depth for soil samples included in the data set are in units of feet
* (in "Units" column) indicates that sample results were reported in μg/kg and have been converted to mg/kg
* (in last column) indicates that the 95% UCL exceeds the maximum value; therefore the maximum value is substituted as the REC instead of the 95% UCL

Table H-5. Chemicals of Potential Concern, Summary Statistics, and Exposure Point Concentrations for Soils - Site 5

178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Total N	Detect	% Detect	NDetect Min	NDetect Max	Detect Min	Detect Max	Mean	MEC	Stand Dev	UCL	REC
Summary Statistics													
Run Time : 10:50:57													
Run Date : 07/29/93													
Site : 5 (s)													
Diesel Fuel	mg/kg	5	5	100	0	0	36	400	139.4	139.4	149.9	282.3	282.3
Heavy Oil	mg/kg	5	4	80	2	2	1	320	133.4	133.4	148.5	275	275
Antimony	mg/kg	5	5	100	0	0	0.39	0.77	0.51	0.51	0.1538	0.6566	0.6566
Arsenic	mg/kg	5	5	100	0	0	7.2	9.5	8.35	8.35	1.005	9.308	9.308
Beryllium	mg/kg	5	5	100	0	0	0.315	0.5	0.445	0.445	0.0742	0.5157	0.5 *
Cadmium (food)	mg/kg	5	5	100	0	0	0.34	21	7.778	7.778	8.2	15.6	15.6
Chromium (III)	mg/kg	5	5	100	0	0	15.1	126	66.1	66.1	53.47	117.1	117.1
Copper	mg/kg	5	5	100	0	0	15.85	48.6	29.01	29.01	13.74	42.11	42.11
Lead	mg/kg	5	5	100	0	0	14.4	268	125.5	125.5	125.3	244.9	244.9
Mercury	mg/kg	5	2	40	0.05	0.06	0.09	0.1	0.055	0.055	0.0367	0.09	0.09
Nickel	mg/kg	5	5	100	0	0	10.3	22.3	17.6	17.6	4.463	21.85	21.85
Thallium	mg/kg	5	5	100	0	0	0.165	0.25	0.205	0.205	0.035	0.2384	0.2384
Zinc	mg/kg	5	5	100	0	0	64.8	643	251.6	251.6	228.2	469.1	469.1
Acenaphthene	mg/kg*	5	3	60	0.36	0.4	0.1435	0.44	0.2307	0.2307	0.1189	0.3441	0.3441
Anthracene	mg/kg*	5	4	80	0.36	0.36	0.11	1.4	0.511	0.511	0.559	1.044	1.044
Benzo(a)anthracene	mg/kg*	5	4	80	0.36	0.36	0.525	16	4.209	4.209	6.754	10.65	10.65
Benzo(a)pyrene	mg/kg*	5	5	100	0	0	0.042	17	4.62	4.62	7.164	11.45	11.45
Benzo(b)fluoranthene	mg/kg*	5	5	100	0	0	0.069	28	7.537	7.537	11.82	18.8	18.8
Benzo(g,h,i)perylene	mg/kg*	5	4	80	0.36	0.36	0.67	13	4.244	4.244	5.532	9.519	9.519
Benzo(k)fluoranthene	mg/kg*	5	4	80	0.36	0.36	0.41	10	2.634	2.634	4.188	6.627	6.627
Carbazole	mg/kg*	5	4	80	0.36	0.36	0.059	1.2	0.3678	0.3678	0.4698	0.8157	0.8157
Chrysene	mg/kg*	5	5	100	0	0	0.039	16	4.536	4.536	6.714	10.94	10.94
Dibenzo(a,h)anthracene	mg/kg*	5	3	60	0.36	0.4	0.17	4.5	1.19	1.19	1.876	2.979	2.979
Dibenzofuran	mg/kg*	5	3	60	0.36	0.4	0.1	0.22	0.1663	0.1663	0.0495	0.2135	0.2135
Di-n-octyl phthalate	mg/kg*	5	1	20	0.36	0.57	0.142	0.142	0.2014	0.142 *	0.0524	0.2514	0.142 *
Fluoranthene	mg/kg*	5	5	100	0	0	0.06	24	7.669	7.669	10.1	17.3	17.3
Fluorene	mg/kg*	5	3	60	0.36	0.4	0.165	0.45	0.249	0.249	0.1169	0.3604	0.3604
Indeno(1,2,3-cd)pyrene	mg/kg*	5	4	80	0.36	0.36	0.71	18	5.124	5.124	7.562	12.33	12.33
2-Methylnaphthalene	mg/kg*	5	1	20	0.36	0.57	2.8	2.8	0.7415	0.7415	1.151	1.839	1.839
Naphthalene	mg/kg*	5	1	20	0.36	0.57	0.45	0.45	0.2715	0.2715	0.1077	0.3742	0.3742
Phenanthrene	mg/kg*	5	4	80	0.36	0.36	0.79	8.2	3.111	3.111	3.462	6.412	6.412
Pyrene	mg/kg*	5	5	100	0	0	0.053	30	9.341	9.341	12.64	21.39	21.39
Samples included in data set													
Sample	Lab #	Depth to	Depth to	Site	Matrix	Depth Class.							
SD5-1	89650	0	0.5	5	SOIL	s							
SD5-2	89651	0	0.5	5	SOIL	s							
SD5-3	89652	0	0.5	5	SOIL	s							
SD5-4	89653	0	0.5	5	SOIL	s							
SD5-5	89654	0	0.5	5	SOIL	s							
Parameter	Units	Total N	Detect	% Detect	NDetect Min	NDetect Max	Detect Min	Detect Max	Mean	MEC	Stand Dev	UCL	REC
Summary Statistics													
Run Time : 9:28:46													
Run Date : 08/2/93													
Site : 5 (d)													

Table H-5. Chemicals of Potential Concern, Summary Statistics, and Exposure Point Concentrations for Soils - Site 5 (continued)

178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Total N	Detect	% Detect	NDetect Min	NDetect Max	Detect Min	Detect Max	Mean	MEC		Stand Dev	UCL	REC	
Summary Statistics															
Diesel Fuel	mg/kg	2	2	100	0	0	8	42	25	25		24.04	132.3	42	*
Heavy Oil	mg/kg	2	2	100	0	0	5	18	11.5	11.5		9.192	52.54	18	*
Antimony	mg/kg	2	1	50	0.23	0.23	0.32	0.32	0.2175	0.2175		0.145	0.8647	0.32	*
Arsenic	mg/kg	2	2	100	0	0	6.7	9.1	7.9	7.9		1.697	15.48	9.1	*
Beryllium	mg/kg	2	2	100	0	0	0.29	0.46	0.375	0.375		0.1202	0.9117	0.46	*
Chromium (III)	mg/kg	2	2	100	0	0	7.4	10.8	9.1	9.1		2.404	19.83	10.8	*
Copper	mg/kg	2	2	100	0	0	13.3	18	15.65	15.65		3.323	30.49	18	*
Lead	mg/kg	2	2	100	0	0	8.2	9.2	8.7	8.7		0.7071	11.86	9.2	*
Nickel	mg/kg	2	2	100	0	0	12	17.3	14.65	14.65		3.748	31.38	17.3	*
Silver	mg/kg	2	1	50	1.9	1.9	1.6	1.6	1.275	1.275		0.4596	3.327	1.6	*
Thallium	mg/kg	2	2	100	0	0	0.21	0.42	0.315	0.315		0.1485	0.9779	0.42	*
Zinc	mg/kg	2	2	100	0	0	45.6	53.5	49.55	49.55		5.586	74.49	53.5	*
Acetone	mg/kg*	2	1	50	0.012	0.012	0.016	0.016	0.011	0.011		0.0071	0.0426	0.016	*
Fluoranthene	mg/kg*	2	1	50	0.34	0.34	0.042	0.042	0.106	0.042	*	0.0905	0.5101	0.042	*
Samples included in data set															
Sample	Lab #	Depth to	Depth to	Site	Matrix	Depth Class.									
SB5-1-1	94674	5	7	5	SOIL	d									
SB5-2-1	94801	5	7	5	SOIL	d									
Merged depths - conservative comparison															
Site : 5															
Diesel Fuel	mg/kg	5	5	100	0	0	36	400	139.4	139.4		149.9	282.3	282.3	
Heavy Oil	mg/kg	5	4	80	2	2	1	320	133.4	133.4		148.5	275	275	
Antimony	mg/kg	5	5	100	0	0	0.39	0.77	0.51	0.51		0.1538	0.6566	0.6566	
Arsenic	mg/kg	5	5	100	0	0	7.2	9.5	8.35	8.35		1.005	9.308	9.308	
Beryllium	mg/kg	5	5	100	0	0	0.315	0.5	0.445	0.445		0.0742	0.5157	0.5	*
Cadmium (food)	mg/kg	5	5	100	0	0	0.34	21	7.778	7.778		8.2	15.6	15.6	
Chromium (III)	mg/kg	5	5	100	0	0	15.1	126	66.1	66.1		53.47	117.1	117.1	
Copper	mg/kg	5	5	100	0	0	15.85	48.6	29.01	29.01		13.74	42.11	42.11	
Lead	mg/kg	5	5	100	0	0	14.4	268	125.5	125.5		125.3	244.9	244.9	
Mercury	mg/kg	5	2	40	0.05	0.06	0.09	0.1	0.055	0.055		0.0367	0.09	0.09	
Nickel	mg/kg	5	5	100	0	0	10.3	22.3	17.6	17.6		4.463	21.85	21.85	
Silver	mg/kg	2	1	50	1.9	1.9	1.6	1.6	1.275	1.275		0.4596	3.327	1.6	*
Thallium	mg/kg	2	2	100	0	0	0.21	0.42	0.315	0.315		0.1485	0.9779	0.42	*
Zinc	mg/kg	5	5	100	0	0	64.8	643	251.6	251.6		228.2	469.1	469.1	
Acenaphthene	mg/kg*	5	3	60	0.36	0.4	0.1435	0.44	0.2307	0.2307		0.1189	0.3441	0.3441	
Acetone	mg/kg*	2	1	50	0.012	0.012	0.016	0.016	0.011	0.011		0.0071	0.0426	0.016	*
Anthracene	mg/kg*	5	4	80	0.36	0.36	0.11	1.4	0.511	0.511		0.559	1.044	1.044	
Benzo(a)anthracene	mg/kg*	5	4	80	0.36	0.36	0.525	16	4.209	4.209		6.754	10.65	10.65	
Benzo(a)pyrene	mg/kg*	5	5	100	0	0	0.042	17	4.62	4.62		7.164	11.45	11.45	
Benzo(b)fluoranthene	mg/kg*	5	5	100	0	0	0.069	28	7.537	7.537		11.82	18.8	18.8	
Benzo(g,h,i)perylene	mg/kg*	5	4	80	0.36	0.36	0.67	13	4.244	4.244		5.532	9.519	9.519	
Benzo(k)fluoranthene	mg/kg*	5	4	80	0.36	0.36	0.41	10	2.634	2.634		4.188	6.627	6.627	
Carbazole	mg/kg*	5	4	80	0.36	0.36	0.059	1.2	0.3678	0.3678		0.4698	0.8157	0.8157	
Chrysene	mg/kg*	5	5	100	0	0	0.039	16	4.536	4.536		6.714	10.94	10.94	
Dibenzo(a,h)anthracene	mg/kg*	5	3	60	0.36	0.4	0.17	4.5	1.19	1.19		1.876	2.979	2.979	
Dibenzofuran	mg/kg*	5	3	60	0.36	0.4	0.1	0.22	0.1663	0.1663		0.0495	0.2135	0.2135	
Di-n-octyl phthalate	mg/kg*	5	1	20	0.36	0.57	0.142	0.142	0.2014	0.142	*	0.0524	0.2514	0.142	*
Fluoranthene	mg/kg*	5	5	100	0	0	0.06	24	7.669	7.669		10.1	17.3	17.3	
Fluorene	mg/kg*	5	3	60	0.36	0.4	0.165	0.45	0.249	0.249		0.1169	0.3604	0.3604	

Table H-5. Chemicals of Potential Concern, Summary Statistics, and Exposure Point Concentrations for Soils - Site 5 (continued)

178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Total N	Detect	% Detect	NDetect Min	NDetect Max	Detect Min	Detect Max	Mean	MEC	Stand Dev	UCL	REC
Summary Statistics													
Indeno(1,2,3-cd)pyrene	mg/kg*	5	4	80	0.36	0.36	0.71	18	5.124	5.124	7.562	12.33	12.33
2-Methylnaphthalene	mg/kg*	5	1	20	0.36	0.57	2.8	2.8	0.7415	0.7415	1.151	1.839	1.839
Naphthalene	mg/kg*	5	1	20	0.36	0.57	0.45	0.45	0.2715	0.2715	0.1077	0.3742	0.3742
Phenanthrene	mg/kg*	5	4	80	0.36	0.36	0.79	8.2	3.111	3.111	3.462	6.412	6.412
Pyrene	mg/kg*	5	5	100	0	0	0.053	30	9.341	9.341	12.64	21.39	21.39

Total N	Total number of samples collected
Detect	Total number of samples in which the analyte was detected
% Detect	Percent of samples in which the analyte was detected
NDetect Min	Minumum Contract Required Limit (CRL)
NDetect Max	Maximum CRL
Detect Min	Minimum detected value
Detect Max	Maximum detected value
MEC	MLE exposure concentration
Stand Dev	Standard deviation
UCL	95% upper confidence limit on the mean
REC	RME exposure concentration
Merged depths	Data set includes both surface and subsurface soils (0 to 10 feet)

Depth for soil samples included in the data set are in units of feet

* (in "Units" column) indicates that sample results were reported in µg/kg and have been converted to mg/kg

* (in last column) indicates that the 95% UCL exceeds the maximum value; therefore the maximum value is substituted as the REC instead of the 95% UCL

Table H-6. Chemicals of Potential Concern, Summary Statistics, and Exposure Point Concentrations for Soils - Background
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Total N	Detect	% Detect	NDetect Min	NDetect Max	Detect Min	Detect Max	Mean	MEC		Stand Dev	UCL	REC	
Summary Statistics															
Run Time : 09:19:29															
Run Date : 08/02/93															
Site : BK (s)															
Diesel Fuel	mg/kg	6	4	67	2	2	3	37	12.08	12.08		14.87	24.31	24.31	
Heavy Oil	mg/kg	6	6	100	0	0	2	160	51.58	51.58		66.5	106.3	106.3	
Antimony	mg/kg	5	3	60	0.15	0.17	0.0975	0.21	0.1175	0.1175		0.0544	0.1693	0.1693	
Arsenic	mg/kg	6	6	100	0	0	6.1	11.3	8.433	8.433		2.038	10.11	10.11	
Beryllium	mg/kg	6	6	100	0	0	0.27	0.55	0.4125	0.4125		0.1368	0.5251	0.5251	
Cadmium (food)	mg/kg	6	2	33	0.17	0.58	0.3	1.5	0.3942	0.3942		0.5509	0.8473	0.8473	
Chromium (III)	mg/kg	6	6	100	0	0	6.4	121	29.93	29.93		44.84	66.82	66.82	
Copper	mg/kg	6	6	100	0	0	11.7	48.7	20.64	20.64		14	32.16	32.16	
Lead	mg/kg	6	6	100	0	0	8.2	126	32.67	32.67		45.93	70.45	70.45	
Mercury	mg/kg	6	1	17	0.04	0.11	0.5	0.5	0.1171	0.1171		0.188	0.2717	0.2717	
Nickel	mg/kg	6	6	100	0	0	13	61.5	22.85	22.85		19.12	38.58	38.58	
Selenium	mg/kg	6	1	17	0.06	0.375	0.25	0.25	0.1117	0.1117		0.0865	0.1829	0.1829	
Silver	mg/kg	6	4	67	0.97	1.6	0.635	5.3	1.737	1.737		1.812	3.227	3.227	
Thallium	mg/kg	6	4	67	0.17	0.3	0.1675	0.4	0.2413	0.2413		0.126	0.3449	0.3449	
Zinc	mg/kg	6	6	100	0	0	39.1	343	100.3	100.3		119.5	198.6	198.6	
Acenaphthylene	mg/kg*	6	2	33	0.33	0.4	0.041	0.1095	0.1447	0.1095	*	0.0591	0.1933	0.1095	*
Anthracene	mg/kg*	6	1	17	0.33	0.4	0.116	0.116	0.1714	0.116	*	0.0301	0.1962	0.116	*
Benzo(a)anthracene	mg/kg*	6	2	33	0.33	0.4	0.177	0.205	0.1833	0.1833		0.0157	0.1961	0.1961	
Benzo(a)pyrene	mg/kg*	6	2	33	0.33	0.4	0.193	0.22	0.1884	0.1884		0.02	0.2049	0.2049	
Benzo(b)fluoranthene	mg/kg*	6	3	50	0.33	0.355	0.047	0.419	0.2256	0.2256		0.1405	0.3412	0.3412	
Benzo(g,h,i)perylene	mg/kg*	6	2	33	0.33	0.4	0.195	0.211	0.1873	0.1873		0.0175	0.2016	0.2016	
Benzo(k)fluoranthene	mg/kg*	6	2	33	0.33	0.4	0.125	0.153	0.1659	0.153	*	0.0254	0.1868	0.153	*
Carbazole	mg/kg*	6	1	17	0.33	0.4	0.112	0.112	0.1708	0.112	*	0.0316	0.1967	0.112	*
Chrysene	mg/kg*	6	2	33	0.33	0.4	0.214	0.245	0.1961	0.1961		0.03	0.2207	0.2207	
Ethylbenzene	mg/kg*	6	1	17	0.011	0.012	0.0063	0.0063	0.0058	0.0058		0.0003	0.0061	0.0061	
Fluoranthene	mg/kg*	6	3	50	0.33	0.355	0.082	0.44	0.2228	0.2228		0.1266	0.3269	0.3269	
Indeno(1,2,3-cd)pyrene	mg/kg*	6	2	33	0.33	0.4	0.225	0.274	0.2028	0.2028		0.041	0.2365	0.2365	
Phenanthrene	mg/kg*	6	2	33	0.33	0.4	0.102	0.265	0.1808	0.1808		0.0528	0.2242	0.2242	
Pyrene	mg/kg*	6	3	50	0.33	0.355	0.075	0.44	0.2223	0.2223		0.1287	0.3281	0.3281	
Toluene	mg/kg*	6	1	17	0.011	0.012	0.012	0.012	0.0068	0.0068		0.0026	0.0089	0.0089	
Xylenes	mg/kg*	6	1	17	0.011	0.012	0.0068	0.0068	0.0059	0.0059		0.0005	0.0063	0.0063	

Samples included in data set

Sample	Lab #	Depth to	Depth to	Site	Matrix	Depth Class.
MWBG-1-1s	94527	1.3	2	BK	SOIL	s
MWBG-2-1s	94912	0.5	2	BK	SOIL	s
SB5-3-1	94803	0.5	2	BK	SOIL	s
SB5-4-1	94805	0.5	2.5	BK	SOIL	s
SD3-1	9555	0	0.5	BK	SOIL	s
SD3-2	9556	0	0.5	BK	SOIL	s

Total N	Total number of samples collected
Detect	Total number of samples in which the analyte was detected
% Detect	Percent of samples in which the analyte was detected
NDetect Min	Minumum Contract Required Limit (CRL)
NDetect Max	Maximum CRL
Detect Min	Minimum detected value
Detect Max	Maximum detected value
MEC	MLE exposure concentration
Stand Dev	Standard deviation
UCL	95% upper confidence limit on the mean
REC	RME exposure concentration
Merged depths	Data set includes both surface and subsurface soils (0 to 10 feet)

Depth for soil samples included in the data set are in units of feet
* (in "Units" column) indicates that sample results were reported in μg/kg and have been converted to mg/kg
* (in last column) indicates that the 95% UCL exceeds the maximum value; therefore the maximum value is substituted as the REC instead of the 95% UCL

Table H-7. Chemicals of Potential Concern, Summary Statistics, and Exposure Point Concentrations for Groundwater - Background
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Total N	Detect	% Detect	NDetect Min	NDetect Max	Detect Min	Detect Max	Mean	MEC	Stand Dev	UCL	REC
Summary Statistics													
Run Time : 09:20:44													
Run Date : 08/02/93													
Site : BK ()													
Antimony	mg/L*	5	5	100	0	0	0.0009	0.0015	0.0012	0.0012	0.0003	0.0015	0.0015
Arsenic	mg/L*	5	5	100	0	0	0.0028	0.0162	0.0068	0.0068	0.0054	0.0119	0.0119
Beryllium	mg/L*	6	5	83	0.0003	0.0003	0.0005	0.0042	0.0015	0.0015	0.0016	0.0028	0.0028
Chromium (III)	mg/L*	6	6	100	0	0	0.0091	0.15	0.0505	0.0505	0.0546	0.0954	0.0954
Copper	mg/L*	6	4	67	0.0116	0.0344	0.0245	0.21	0.0676	0.0676	0.0788	0.1324	0.1324
Lead	mg/L*	6	4	67	0.0041	0.0166	0.0098	0.104	0.0324	0.0324	0.0399	0.0652	0.0652
Nickel	mg/L*	6	5	83	0.0129	0.0129	0.0217	0.247	0.0777	0.0777	0.0945	0.1555	0.1555
Silver	mg/L*	6	2	33	0.0029	0.0038	0.0031	0.0033	0.0022	0.0022	0.0008	0.0029	0.0029
Zinc	mg/L*	6	4	67	0.0397	0.132	0.0971	0.763	0.2689	0.2689	0.2994	0.5152	0.5152
Antimony (d)	mg/L*	4	4	100	0	0	0.0009	0.002	0.0014	0.0014	0.0004	0.0019	0.0019
Lead (d)	mg/L*	4	1	25	0.0005	0.0006	0.0067	0.0067	0.0019	0.0019	0.0032	0.0057	0.0057
1,2-Dichloroethylene	mg/L*	6	1	17	0.0005	0.0005	0.0006	0.0006	0.0003	0.0003	0.0001	0.0004	0.0004
Trichloroethylene	mg/L*	6	1	17	0.0005	0.0005	0.0007	0.0007	0.0003	0.0003	0.0002	0.0005	0.0005
Samples included in data set													
Sample	Lab #	Depth to	Depth to	Site	Matrix	Depth Class.							
MWBG-1-1	97309			BK	WATER								
MWBG-1-2	#######			BK	WATER								
MWBG-2-1	97271			BK	WATER								
MWBG-2-2	#######			BK	WATER								
P-4-1	#######			BK	WATER								
P-5-1	#######			BK	WATER								

Total N	Total number of samples collected
Detect	Total number of samples in which the analyte was detected
% Detect	Percent of samples in which the analyte was detected
NDetect Min	Minumum Contract Required Limit (CRL)
NDetect Max	Maximum CRL
Detect Min	Minimum detected value
Detect Max	Maximum detected value
MEC	MLE exposure concentration
Stand Dev	Standard deviation
UCL	95% upper confidence limit on the mean
REC	RME exposure concentration
Merged depths	Data set includes both surface and subsurface soils (0 to 10 feet)

Depth for soil samples included in the data set are in units of feet
* (in "Units" column) indicates that sample results were reported in µg/kg and have been converted to mg/kg
* (in last column) indicates that the 95% UCL exceeds the maximum value; therefore the maximum value is substituted as the REC instead of the 95% UCL

Table H-8. Risk Estimate Summary - RME Risks
Site 2 - Fire Training Area 2
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

CURRENT - OCCUPATIONAL

MEDIA	ROUTE	BASE PERSONNEL				CONSTRUCTION WORKER			
		Noncancer		Cancer		Noncancer		Cancer	
Soil	Ingestion	2.3E-02	B	9.7E-06	W	2.8E-01	B	9.3E-06	W
	Dermal	1.7E-03	B	3.6E-06	W	4.7E-03	B	7.1E-07	B
Soil Total	**Combined**	**2.5E-02**	B	**1.3E-05**	W	**2.9E-01**	B	**1.0E-05**	W

TOTAL	**2.5E-02**	B	**1.3E-05**	W	**2.9E-01**	B	**1.0E-05**	W

FUTURE - RESIDENTIAL

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Soil	Ingestion	7.7E-01	B	7.6E-05	W	8.3E-02	B	3.3E-05	W
	Inhalation	2.9E-07	B	1.8E-08	B	6.2E-08	B	1.9E-08	B
	Dermal	1.1E-02	B	4.9E-06	W	6.6E-03	B	1.5E-05	W
Soil Total	**Combined**	**7.8E-01**	B	**8.1E-05**	W	**8.9E-02**	B	**4.8E-05**	W

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Air (vapors) Total	**Inhalation**	**6.8E-04**	B	**1.6E-07**	B	**1.5E-04**	B	**1.7E-07**	B

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Groundwater	Ingestion	2.1E+01	E	9.9E-04	E	8.8E+00	E	2.1E-03	E
	Inhalation	--	--	--	--	--	--	--	--
	Dermal	2.5E-02	B	1.5E-05	W	1.4E-02	B	8.3E-06	W
GW Total	**Combined**	**2.1E+01**	E	**1.0E-03**	E	**8.9E+00**	E	**2.1E-03**	E

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Filtered Groundwater	Ingestion	7.0E-01	B	2.0E-05	W	3.0E-01	B	4.3E-05	W
	Inhalation	--	--	--	--	--	--	--	--
	Dermal	9.3E-04	B	3.1E-07	B	5.0E-04	B	1.7E-07	B
FGW Total	**Combined**	**7.0E-01**	B	**2.0E-05**	W	**3.0E-01**	B	**4.3E-05**	W

TOTAL *	**2.1E+01**	E	**1.1E-03**	E	**8.9E+00**	E	**2.2E-03**	E

"B" - Below EPA human noncancer health effects target (HI < 1) or cancer risk (ELCR < 1 x 10-6)
"W" - Within EPA target cancer risk range (ELCR <= 1 x 10-4 and >= 1 x 10-6)
"E" - Exceeds EPA human noncancer health effects target (HI > 1) or cancer risks (ELCR > 1 x 10E-4)
* - TOTAL does not include risks from filtered groundwater
-- No results are available for this route because detected chemicals do not easily volatilize and/or have no EPA-approved toxicity values

TABLE H-9. RISK FROM SOIL INGESTION BY BASE PERSONNEL - CURRENT CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg) MLE	RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	RME	RME % of total ELCR
INORGANICS											
Antimony	3.0E-01	5.3E-01	7.3E-05	5.2E-04	2%	whole body, blood; inc. mortality	1000				
Arsenic	9.8E+00	1.5E+01	3.2E-03	1.9E-02	84%	skin; keratosis, hyperpigmentation	3	[A]	6.0E-07	3.7E-06	38%
Beryllium	3.5E-01	5.4E-01	6.9E-06	4.3E-05	0%	no observed effects	100	[B2]	5.3E-08	3.3E-07	3%
Cadmium (food)	7.5E-01	1.2E+00	7.3E-05	4.8E-04	2%	kidney; proteinuria	10				
Chromium (III)	1.3E+01	1.9E+01	1.3E-06	7.5E-06	0%	no observed effects	100				
Copper	1.5E+01	2.0E+01	4.0E-05	2.1E-04	1%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.4E+01	7.3E+01				CNS, blood	- -	[B2]			
Mercury	5.5E-02	8.9E-02	1.8E-05	1.2E-04	0%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	1.4E+01	2.0E+01	6.9E-05	3.8E-04	2%	dec. body and organ weight	300				
Thallium	2.0E-01	2.5E-01	2.4E-04	1.2E-03	5%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	6.5E+01	1.1E+02	2.1E-05	1.4E-04	1%	blood; anemia	3	[D]			
ORGANICS											
Acetone	3.2E-02	7.7E-02	3.1E-08	3.0E-07	0%	inc. liver, kidney weights, nephrotoxicity	1000	[D]			
Anthracene	2.7E-01	4.0E-01	8.8E-08	5.2E-07	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	9.8E-01	2.5E+00	3.2E-06	3.2E-05	0%	- -	- -	[B2]	2.5E-08	2.5E-07	3%
Benzo(a)pyrene	1.5E+00	3.9E+00	4.8E-06	5.1E-05	0%	- -	- -	[B2]	3.7E-07	4.0E-06	41%
Benzo(b)fluoranthene	2.4E+00	6.6E+00	7.9E-06	8.6E-05	0%	- -	- -	[B2]	6.2E-08	6.7E-07	7%
Benzo(g,h,i)perylene	1.1E+00	2.7E+00	3.4E-06	3.5E-05	0%	- -	- -	[D]			
Benzo(k)fluoranthene	1.4E+00	3.7E+00	4.6E-06	4.8E-05	0%	- -	- -	[B2]	3.6E-08	3.8E-07	4%
2-Butanone	1.1E-02	2.0E-02	1.8E-09	1.3E-08	0%	oral and inhal. - dec. fetal birth weight	3000	[D]			
Carbazole	6.2E-01	1.5E+00				- -	- -	[B2]	4.3E-10	4.1E-09	0%
Carbon Disulfide	4.0E-03	4.0E-03	3.9E-09	1.6E-08	0%	oral and inhal.-fetus; toxicity	100				
Chrysene	2.1E+00	5.8E+00	7.0E-06	7.6E-05	0%	- -	- -	[B2]	5.5E-09	5.9E-08	1%
Fluoranthene	3.4E+00	9.4E+00	8.3E-06	9.2E-05	0%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Indeno(1,2,3-cd)pyrene	1.4E+00	3.7E+00	4.6E-06	4.9E-05	0%	- -	- -	[B2]	3.6E-08	3.8E-07	4%
Phenanthrene	2.1E+00	5.7E+00	6.7E-06	7.5E-05	0%	- -	- -	[D]			
Pyrene	2.8E+00	7.6E+00	9.1E-06	9.9E-05	0%	kidney; red. weight, renal tubular pathology	3000	[D]			

Summed Hazard Quotient	MLE	RME	
	3.80E-03	2.33E-02	100%

Summed Cancer Risk	MLE	RME	
	1.19E-06	9.73E-06	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-10. RISK FROM SOIL DERMAL CONTACT BY BASE PERSONNEL - CURRENT CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		Noncarcinogenic Effects: RME % of total HQ	Noncarcinogenic Effects: Target Organ System	UF (oral)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	3.0E-01	5.3E-01	1.5E-06	3.0E-05	2%	whole body, blood; inc. mortality	1000				
Arsenic	9.8E+00	1.5E+01	6.4E-05	1.1E-03	67%	skin; keratosis, hyperpigmentation	3	[A]	1.2E-08	2.1E-07	6%
Beryllium	3.5E-01	5.4E-01	1.4E-07	2.5E-06	0%	no observed effects	100	[B2]	1.1E-09	1.9E-08	1%
Cadmium (food)	7.5E-01	1.2E+00	1.5E-06	2.8E-05	2%	kidney; proteinuria	10				
Chromium (III)	1.3E+01	1.9E+01	2.6E-08	4.3E-07	0%	no observed effects	100				
Copper	1.5E+01	2.0E+01	8.0E-07	1.2E-05	1%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.4E+01	7.3E+01				CNS, blood	- -	[B2]			
Mercury	5.5E-02	8.9E-02	3.6E-07	6.7E-06	0%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	1.4E+01	2.0E+01	1.4E-06	2.2E-05	1%	dec. body and organ weight	300				
Thallium	2.0E-01	2.5E-01	4.9E-06	7.2E-05	4%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	6.5E+01	1.1E+02	4.2E-07	8.1E-06	0%	blood; anemia	3	[D]			
ORGANICS											
Acetone	3.2E-02	7.7E-02	6.3E-09	1.8E-07	0%	inc. liver, kidney weights, nephrotoxicity	1000	[D]			
Anthracene	2.7E-01	4.0E-01	1.8E-08	3.0E-07	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	9.8E-01	2.5E+00	6.4E-07	1.9E-05	1%	- -	- -	[B2]	5.0E-09	1.5E-07	4%
Benzo(a)pyrene	1.5E+00	3.9E+00	9.5E-07	3.0E-05	2%	- -	- -	[B2]	7.4E-08	2.3E-06	65%
Benzo(b)fluoranthene	2.4E+00	6.6E+00	1.6E-06	5.0E-05	3%	- -	- -	[B2]	1.2E-08	3.9E-07	11%
Benzo(g,h,i)perylene	1.1E+00	2.7E+00	6.9E-07	2.0E-05	1%	- -	- -	[D]			
Benzo(k)fluoranthene	1.4E+00	3.7E+00	9.1E-07	2.8E-05	2%	- -	- -	[B2]	7.1E-09	2.2E-07	6%
2-Butanone	1.1E-02	2.0E-02	3.5E-10	7.4E-09	0%	oral and inhal. - dec. fetal birth weight	3000	[D]			
Carbazole	6.2E-01	1.5E+00				- -	- -	[B2]	8.6E-11	2.4E-09	0%
Carbon Disulfide	4.0E-03	4.0E-03	7.8E-10	9.1E-09	0%	oral and inhal.-fetus; toxicity	100				
Chrysene	2.1E+00	5.8E+00	1.4E-06	4.4E-05	3%	- -	- -	[B2]	1.1E-09	3.4E-08	1%
Fluoranthene	3.4E+00	9.4E+00	1.7E-06	5.3E-05	3%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Indeno(1,2,3-cd)pyrene	1.4E+00	3.7E+00	9.3E-07	2.8E-05	2%	- -	- -	[B2]	7.2E-09	2.2E-07	6%
Phenanthrene	2.1E+00	5.7E+00	1.3E-06	4.3E-05	3%	- -	- -	[D]			
Pyrene	2.8E+00	7.6E+00	1.8E-06	5.8E-05	3%	kidney; red. weight, renal tubular pathology	3000	[D]			
Summed Hazard Quotient			MLE 8.67E-05	RME 1.69E-03	100%						
Summed Cancer Risk									MLE 1.20E-07	RME 3.57E-06	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-11. RISK FROM SOIL INGESTION BY CONSTRUCTION WORKER - CURRENT CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Construction Zone Soil (mg/kg) MLE	RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	RME	RME % of total ELCR
INORGANICS											
Antimony	3.0E-01	5.3E-01	1.5E-03	6.2E-03	2%	whole body, blood; inc. mortality	1000	- -			
Arsenic	9.8E+00	1.5E+01	6.4E-02	2.3E-01	82%	skin; keratosis, hyperpigmentation	3	[A]	9.6E-07	3.5E-06	38%
Beryllium	3.5E-01	5.4E-01	1.4E-04	5.1E-04	0%	no observed effects	100	[B2]	8.5E-08	3.1E-07	3%
Cadmium (food)	7.5E-01	1.2E+00	1.5E-03	5.7E-03	2%	kidney; proteinuria	10	- -			
Chromium (III)	1.3E+01	1.9E+01	2.6E-05	9.0E-05	0%	no observed effects	100	- -			
Copper	1.5E+01	2.0E+01	8.0E-04	2.5E-03	1%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.4E+01	7.3E+01				CNS, blood	- -	[B2]			
Mercury	5.5E-02	8.9E-02	3.6E-04	1.4E-03	0%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	1.4E+01	2.0E+01	1.4E-03	4.6E-03	2%	dec. body and organ weight	300	- -			
Silver	9.6E-01	1.3E+00	3.8E-04	1.2E-03	0%	skin; argyria	3	[D]			
Thallium	2.0E-01	2.5E-01	4.9E-03	1.5E-02	5%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	6.5E+01	1.1E+02	4.2E-04	1.7E-03	1%	blood; anemia	3	[D]			
ORGANICS											
Acetone	1.6E-01	3.3E-01	3.2E-06	1.5E-05	0%	inc. liver, kidney weights, nephrotoxicity	1000	[D]			
Anthracene	2.7E-01	4.0E-01	1.8E-06	6.3E-06	0%	no observed effects	3000	[D]			
Benzene	1.4E-01	3.1E-01	6.8E-04	3.6E-03	1%	- -	- -	[A]	2.3E-10	1.2E-09	0%
Benzo(a)anthracene	9.8E-01	2.5E+00	6.4E-05	3.9E-04	0%	- -	- -	[B2]	4.0E-08	2.4E-07	3%
Benzo(a)pyrene	1.5E+00	3.9E+00	9.5E-05	6.2E-04	0%	- -	- -	[B2]	6.0E-07	3.9E-06	41%
Benzo(b)fluoranthene	2.4E+00	6.6E+00	1.6E-04	1.0E-03	0%	- -	- -	[B2]	9.9E-08	6.4E-07	7%
Benzo(g,h,i)perylene	1.1E+00	2.7E+00	6.9E-05	4.2E-04	0%	- -	- -	[D]			
Benzo(k)fluoranthene	1.4E+00	3.7E+00	9.1E-05	5.8E-04	0%	- -	- -	[B2]	5.7E-08	3.6E-07	4%
2-Butanone	1.9E-02	1.9E-02	6.2E-08	1.5E-07	0%	oral and inhal. - dec. fetal birth weight	3000	[D]			
Carbazole	6.2E-01	1.5E+00				- -	- -	[B2]	6.9E-10	3.9E-09	0%
Carbon Disulfide	4.0E-03	4.0E-03	7.8E-08	1.9E-07	0%	oral and inhal.-fetus; toxicity	100	- -			
Chrysene	2.1E+00	5.8E+00	1.4E-04	9.1E-04	0%	- -	- -	[B2]	8.8E-09	5.7E-08	1%
Ethylbenzene	1.8E-01	3.4E-01	3.5E-06	1.6E-05	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	3.4E+00	9.4E+00	1.7E-04	1.1E-03	0%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Indeno(1,2,3-cd)pyrene	1.4E+00	3.7E+00	9.3E-05	5.8E-04	0%	- -	- -	[B2]	5.8E-08	3.6E-07	4%
Isophorone	3.5E-01	5.3E-01	3.4E-06	1.2E-05	0%	kidney; lesions	1000	[C]	1.9E-11	6.7E-11	0%
2-Methylnaphthalene	8.1E-01	1.5E+00	5.3E-05	2.4E-04	0%	skin effects	- -	- -			
4-Methyl-2-pentanone	5.0E-02	5.0E-02	1.2E-06	2.9E-06	0%	oral and inhal.-liver, kidney effects	3000	- -			
Naphthalene	4.2E-01	7.0E-01				dec. body weight	- -	[D]			
Pentachlorophenol	1.3E-01	1.3E-01	8.5E-06	2.0E-05	0%	liver, adrenal effects, fetotoxicity	100	[B2]	8.7E-10	2.1E-09	0%
Phenanthrene	2.1E+00	5.7E+00	1.3E-04	9.0E-04	0%	- -	- -	[D]			
Pyrene	2.8E+00	7.6E+00	1.8E-04	1.2E-03	0%	kidney; red. weight, renal tubular pathology	3000	[D]			
Xylenes	3.2E-01	6.4E-01	3.1E-07	1.5E-06	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 7.71E-02	RME 2.84E-01	100%						
Summed Cancer Risk									MLE 1.90E-06	RME 9.35E-06	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-12. RISK FROM SOIL DERMAL CONTACT BY CONSTRUCTION WORKER - CURRENT CONDITIONS SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Construction Zone Soil (mg/kg) MLE	RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	RME	RME % of total HQ	Target Organ System	UF (oral)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	RME	RME % of total ELCR
INORGANICS											
Antimony	3.0E-01	5.3E-01	7.3E-06	7.5E-05	2%	whole body, blood; inc. mortality	1000	- -			
Arsenic	9.8E+00	1.5E+01	3.2E-04	2.8E-03	60%	skin; keratosis, hyperpigmentation	3	[A]	4.8E-09	4.2E-08	6%
Beryllium	3.5E-01	5.4E-01	6.9E-07	6.2E-06	0%	no observed effects	100	[B2]	4.2E-10	3.8E-09	1%
Cadmium (food)	7.5E-01	1.2E+00	7.3E-06	6.9E-05	1%	kidney; proteinuria	10	- -			
Chromium (III)	1.3E+01	1.9E+01	1.3E-07	1.1E-06	0%	no observed effects	100	- -			
Copper	1.5E+01	2.0E+01	4.0E-06	3.1E-05	1%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.4E+01	7.3E+01				CNS, blood	- -	[B2]			
Mercury	5.5E-02	8.9E-02	1.8E-06	1.7E-05	0%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	1.4E+01	2.0E+01	6.9E-06	5.6E-05	1%	dec. body and organ weight	300	- -			
Silver	9.6E-01	1.3E+00	1.9E-06	1.5E-05	0%	skin; argyria	3	[D]			
Thallium	2.0E-01	2.5E-01	2.4E-05	1.8E-04	4%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	6.5E+01	1.1E+02	2.1E-06	2.0E-05	0%	blood; anemia	3	[D]			
ORGANICS											
Acetone	1.6E-01	3.3E-01	1.6E-07	1.9E-06	0%	inc. liver, kidney weights, nephrotoxicity	1000	[D]			
Anthracene	2.7E-01	4.0E-01	8.8E-08	7.6E-07	0%	no observed effects	3000	[D]			
Benzene	1.4E-01	3.1E-01	3.4E-05	4.4E-04	9%	- -	- -	[A]	1.1E-11	1.4E-10	0%
Benzo(a)anthracene	9.8E-01	2.5E+00	3.2E-06	4.7E-05	1%	- -	- -	[B2]	2.0E-09	2.9E-08	4%
Benzo(a)pyrene	1.5E+00	3.9E+00	4.8E-06	7.4E-05	2%	- -	- -	[B2]	3.0E-08	4.7E-07	65%
Benzo(b)fluoranthene	2.4E+00	6.6E+00	7.9E-06	1.2E-04	3%	- -	- -	[B2]	5.0E-09	7.8E-08	11%
Benzo(g,h,i)perylene	1.1E+00	2.7E+00	3.4E-06	5.1E-05	1%	- -	- -	[D]			
Benzo(k)fluoranthene	1.4E+00	3.7E+00	4.6E-06	7.0E-05	1%	- -	- -	[B2]	2.9E-09	4.4E-08	6%
2-Butanone	1.9E-02	1.9E-02	3.1E-09	1.8E-08	0%	oral and inhal. - dec. fetal birth weight	3000	[D]			
Carbazole	6.2E-01	1.5E+00				- -	- -	[B2]	3.4E-11	4.7E-10	0%
Carbon Disulfide	4.0E-03	4.0E-03	3.9E-09	2.3E-08	0%	oral and inhal.-fetus; toxicity	100	- -			
Chrysene	2.1E+00	5.8E+00	7.0E-06	1.1E-04	2%	- -	- -	[B2]	4.4E-10	6.9E-09	1%
Ethylbenzene	1.8E-01	3.4E-01	1.7E-07	2.0E-06	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	3.4E+00	9.4E+00	8.3E-06	1.3E-04	3%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Indeno(1,2,3-cd)pyrene	1.4E+00	3.7E+00	4.6E-06	7.0E-05	1%	- -	- -	[B2]	2.9E-09	4.4E-08	6%
Isophorone	3.5E-01	5.3E-01	1.7E-07	1.5E-06	0%	kidney; lesions	1000	[C]	9.3E-13	8.1E-12	0%
2-Methylnaphthalene	8.1E-01	1.5E+00	2.7E-06	2.9E-05	1%	skin effects	- -	- -			
4-Methyl-2-pentanone	5.0E-02	5.0E-02	6.1E-08	3.5E-07	0%	oral and inhal.-liver, kidney effects	3000	- -			
Naphthalene	4.2E-01	7.0E-01				dec. body weight	- -	[D]			
Pentachlorophenol	1.3E-01	1.3E-01	4.2E-07	2.5E-06	0%	liver, adrenal effects, fetotoxicity	100	[B2]	4.4E-11	2.5E-10	0%
Phenanthrene	2.1E+00	5.7E+00	6.7E-06	1.1E-04	2%	- -	- -	[D]			
Pyrene	2.8E+00	7.6E+00	9.1E-06	1.4E-04	3%	kidney; red. weight, renal tubular pathology	3000	[D]			
Xylenes	3.2E-01	6.4E-01	1.5E-08	1.8E-07	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 4.73E-04	RME 4.70E-03	100%						
Summed Cancer Risk									MLE 4.82E-08	RME 7.14E-07	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-13. RISK FROM SOIL INGESTION BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Soil (mg/kg) MLE	Exposure Point Concentration in Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR RME	RME % of total ELCR
INORGANICS											
Antimony	3.0E-01	5.3E-01	7.5E-03	1.7E-02	2%	whole body, blood; inc. mortality	1000	- -			
Arsenic	9.8E+00	1.5E+01	3.3E-01	6.4E-01	82%	skin; keratosis, hyperpigmentation	3	[A]	1.5E-05	2.9E-05	38%
Beryllium	3.5E-01	5.4E-01	7.1E-04	1.4E-03	0%	no observed effects	100	[B2]	1.3E-06	2.6E-06	3%
Cadmium (food)	7.5E-01	1.2E+00	7.5E-03	1.6E-02	2%	kidney; proteinuria	10	- -			
Chromium (III)	1.3E+01	1.9E+01	1.3E-04	2.4E-04	0%	no observed effects	100	- -			
Copper	1.5E+01	2.0E+01	4.1E-03	6.9E-03	1%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.4E+01	7.3E+01				CNS, blood	- -	[B2]			
Mercury	5.5E-02	8.9E-02	1.8E-03	3.8E-03	0%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	1.4E+01	2.0E+01	7.1E-03	1.3E-02	2%	dec. body and organ weight	300	- -			
Silver	9.6E-01	1.3E+00	1.9E-03	3.3E-03	0%	skin; argyria	3	[D]			
Thallium	2.0E-01	2.5E-01	2.5E-02	4.1E-02	5%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	6.5E+01	1.1E+02	2.2E-03	4.5E-03	1%	blood; anemia	3	[D]			
ORGANICS											
Acetone	1.6E-01	3.3E-01	1.6E-05	4.2E-05	0%	inc. liver, kidney weights, nephrotoxicity	1000	[D]			
Anthracene	2.7E-01	4.0E-01	9.0E-06	1.7E-05	0%	no observed effects	3000	[D]			
Benzene	1.4E-01	3.1E-01	3.5E-03	9.8E-03	1%	- -	- -	[A]	3.5E-09	9.8E-09	0%
Benzo(a)anthracene	9.8E-01	2.5E+00	3.3E-04	1.0E-03	0%	- -	- -	[B2]	6.2E-07	2.0E-06	3%
Benzo(a)pyrene	1.5E+00	3.9E+00	4.9E-04	1.7E-03	0%	- -	- -	[B2]	9.2E-06	3.1E-05	41%
Benzo(b)fluoranthene	2.4E+00	6.6E+00	8.1E-04	2.8E-03	0%	- -	- -	[B2]	1.5E-06	5.3E-06	7%
Benzo(g,h,i)perylene	1.1E+00	2.7E+00	3.5E-04	1.1E-03	0%	- -	- -	[D]			
Benzo(k)fluoranthene	1.4E+00	3.7E+00	4.7E-04	1.6E-03	0%	- -	- -	[B2]	8.8E-07	3.0E-06	4%
2-Butanone	1.9E-02	1.9E-02	3.2E-07	4.0E-07	0%	oral and inhal. - dec. fetal birth weight	3000	[D]			
Carbazole	6.2E-01	1.5E+00				- -	- -	[B2]	1.1E-08	3.2E-08	0%
Carbon Disulfide	4.0E-03	4.0E-03	4.0E-07	5.1E-07	0%	oral and inhal.-fetus; toxicity	100	- -			
Chrysene	2.1E+00	5.8E+00	7.2E-04	2.5E-03	0%	- -	- -	[B2]	1.3E-07	4.6E-07	1%
Ethylbenzene	1.8E-01	3.4E-01	1.8E-05	4.4E-05	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	3.4E+00	9.4E+00	8.5E-04	3.0E-03	0%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Indeno(1,2,3-cd)pyrene	1.4E+00	3.7E+00	4.8E-04	1.6E-03	0%	- -	- -	[B2]	8.9E-07	3.0E-06	4%
Isophorone	3.5E-01	5.3E-01	1.8E-05	3.4E-05	0%	kidney; lesions	1000	[C]	2.9E-10	5.5E-10	0%
2-Methylnaphthalene	8.1E-01	1.5E+00	2.7E-04	6.5E-04	0%	skin effects	- -	- -			
4-Methyl-2-pentanone	5.0E-02	5.0E-02	6.3E-06	8.0E-06	0%	oral and inhal.-liver, kidney effects	3000	- -			
Naphthalene	4.2E-01	7.0E-01				dec. body weight	- -	[D]			
Pentachlorophenol	1.3E-01	1.3E-01	4.4E-05	5.5E-05	0%	liver, adrenal effects, fetotoxicity	100	[B2]	1.3E-08	1.7E-08	0%
Phenanthrene	2.1E+00	5.7E+00	6.9E-04	2.4E-03	0%	- -	- -	[D]			
Pyrene	2.8E+00	7.6E+00	9.3E-04	3.2E-03	0%	kidney; red. weight, renal tubular pathology	3000	[D]			
Xylenes	3.2E-01	6.4E-01	1.6E-06	4.1E-06	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 3.96E-01	RME 7.74E-01	100%						
Summed Cancer Risk									MLE 2.93E-05	RME 7.63E-05	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-14. RISK FROM SOIL INHALATION BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Soil (mg/kg)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		Noncarcinogenic Effects: RME % of total HQ	Noncarcinogenic Effects: Target Organ System	Noncarcinogenic Effects: UF (inhalation)	Carcinogenic Effects: WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		Carcinogenic Effects: RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	3.0E-01	5.3E-01				whole body, blood; inc. mortality	--	--			
Arsenic	9.8E+00	1.5E+01				skin; keratosis, hyperpigmentation	--	[A]	9.1E-09	1.8E-08	98%
Beryllium	3.5E-01	5.4E-01				no observed effects	--	[B2]	5.5E-11	1.1E-10	1%
Cadmium (food)	7.5E-01	1.2E+00				kidney; proteinuria	--	--	8.5E-11	1.8E-10	1%
Chromium (III)	1.3E+01	1.9E+01				no observed effects	--	--			
Copper	1.5E+01	2.0E+01				Gastrointestinal system; irritation	--	[D]			
Lead	3.4E+01	7.3E+01				CNS, blood	--	[B2]			
Mercury	5.5E-02	8.9E-02	1.4E-07	2.9E-07	100%	oral-CNS; neurotoxicity. inhal.-kidney effects	30	[D]			
Nickel	1.4E+01	2.0E+01				dec. body and organ weight	--	--			
Silver	9.6E-01	1.3E+00				skin; argyria	--	[D]			
Thallium	2.0E-01	2.5E-01				liver, blood; inc. sgot and serum LDH	--	[D]			
Zinc	6.5E+01	1.1E+02				blood; anemia	--	[D]			
ORGANICS											
Acetone	1.6E-01	3.3E-01				inc. liver, kidney weights, nephrotoxicity	--	[D]			
Anthracene	2.7E-01	4.0E-01				no observed effects	--	[D]			
Benzene	1.4E-01	3.1E-01				--	--	[A]	7.5E-14	2.1E-13	0%
Benzo(a)anthracene	9.8E-01	2.5E+00				--	--	[B2]			
Benzo(a)pyrene	1.5E+00	3.9E+00				--	--	[B2]			
Benzo(b)fluoranthene	2.4E+00	6.6E+00				--	--	[B2]			
Benzo(g,h,i)perylene	1.1E+00	2.7E+00				--	--	[D]			
Benzo(k)fluoranthene	1.4E+00	3.7E+00				--	--	[B2]			
2-Butanone	1.9E-02	1.9E-02	1.4E-11	1.8E-11	0%	oral and inhal. - dec. fetal birth weight	1000	[D]			
Carbazole	6.2E-01	1.5E+00				--	--	[B2]			
Carbon Disulfide	4.0E-03	4.0E-03	3.0E-10	3.9E-10	0%	oral and inhal.-fetus; toxicity	1000	--			
Chrysene	2.1E+00	5.8E+00				--	--	[B2]			
Ethylbenzene	1.8E-01	3.4E-01	1.3E-10	3.3E-10	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	300	[D]			
Fluoranthene	3.4E+00	9.4E+00				kidney, liver, blood; inc. weight, hematological changes	--	[D]			
Indeno(1,2,3-cd)pyrene	1.4E+00	3.7E+00				--	--	[B2]			
Isophorone	3.5E-01	5.3E-01				kidney; lesions	--	[C]			
2-Methylnaphthalene	8.1E-01	1.5E+00				skin effects	--	--			
4-Methyl-2-pentanone	5.0E-02	5.0E-02	4.7E-10	6.0E-10	0%	oral and inhal.-liver, kidney effects	1000	--			
Naphthalene	4.2E-01	7.0E-01				dec. body weight	--	[D]			
Pentachlorophenol	1.3E-01	1.3E-01				liver, adrenal effects, fetotoxicity	--	[B2]			
Phenanthrene	2.1E+00	5.7E+00				--	--	[D]			
Pyrene	2.8E+00	7.6E+00				kidney; red. weight, renal tubular pathology	--	[D]			
Xylenes	3.2E-01	6.4E-01				CNS hyperactivity; dec. body weight	--	[D]			
Summed Hazard Quotient			MLE 1.39E-07	RME 2.88E-07	100%						
Summed Cancer Risk									MLE 9.24E-09	RME 1.80E-08	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-15. RISK FROM SOIL DERMAL CONTACT BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Soil (mg/kg) MLE	Exposure Point Concentration in Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	3.0E-01	5.3E-01	1.3E-05	1.7E-04	2%	whole body, blood; inc. mortality	1000	- -			
Arsenic	9.8E+00	1.5E+01	5.7E-04	6.4E-03	60%	skin; keratosis, hyperpigmentation	3	[A]	2.6E-08	2.9E-07	6%
Beryllium	3.5E-01	5.4E-01	1.2E-06	1.4E-05	0%	no observed effects	100	[B2]	2.3E-09	2.6E-08	1%
Cadmium (food)	7.5E-01	1.2E+00	1.3E-05	1.6E-04	1%	kidney; proteinuria	10	- -			
Chromium (III)	1.3E+01	1.9E+01	2.3E-07	2.5E-06	0%	no observed effects	100	- -			
Copper	1.5E+01	2.0E+01	7.2E-06	6.9E-05	1%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.4E+01	7.3E+01				CNS, blood	- -	[B2]			
Mercury	5.5E-02	8.9E-02	3.2E-06	3.8E-05	0%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	1.4E+01	2.0E+01	1.2E-05	1.3E-04	1%	dec. body and organ weight	300	- -			
Silver	9.6E-01	1.3E+00	3.4E-06	3.3E-05	0%	skin; argyria	3	[D]			
Thallium	2.0E-01	2.5E-01	4.4E-05	4.1E-04	4%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	6.5E+01	1.1E+02	3.8E-06	4.6E-05	0%	blood; anemia	3	[D]			
ORGANICS											
Acetone	1.6E-01	3.3E-01	2.9E-07	4.2E-06	0%	inc. liver, kidney weights, nephrotoxicity	1000	[D]			
Anthracene	2.7E-01	4.0E-01	1.6E-07	1.7E-06	0%	no observed effects	3000	[D]			
Benzene	1.4E-01	3.1E-01	6.1E-05	9.9E-04	9%	- -	- -	[A]	6.1E-11	9.8E-10	0%
Benzo(a)anthracene	9.8E-01	2.5E+00	5.8E-06	1.1E-04	1%	- -	- -	[B2]	1.1E-08	2.0E-07	4%
Benzo(a)pyrene	1.5E+00	3.9E+00	8.5E-06	1.7E-04	2%	- -	- -	[B2]	1.6E-07	3.2E-06	65%
Benzo(b)fluoranthene	2.4E+00	6.6E+00	1.4E-05	2.8E-04	3%	- -	- -	[B2]	2.7E-08	5.3E-07	11%
Benzo(g,h,i)perylene	1.1E+00	2.7E+00	6.2E-06	1.2E-04	1%	- -	- -	[D]			
Benzo(k)fluoranthene	1.4E+00	3.7E+00	8.2E-06	1.6E-04	1%	- -	- -	[B2]	1.5E-08	3.0E-07	6%
2-Butanone	1.9E-02	1.9E-02	5.6E-09	4.1E-08	0%	oral and inhal. - dec. fetal birth weight	3000	[D]			
Carbazole	6.2E-01	1.5E+00				- -	- -	[B2]	1.9E-10	3.2E-09	0%
Carbon Disulfide	4.0E-03	4.0E-03	7.0E-09	5.1E-08	0%	oral and inhal.-fetus; toxicity	100	- -			
Chrysene	2.1E+00	5.8E+00	1.3E-05	2.5E-04	2%	- -	- -	[B2]	2.4E-09	4.7E-08	1%
Ethylbenzene	1.8E-01	3.4E-01	3.1E-07	4.4E-06	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	3.4E+00	9.4E+00	1.5E-05	3.0E-04	3%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Indeno(1,2,3-cd)pyrene	1.4E+00	3.7E+00	8.3E-06	1.6E-04	1%	- -	- -	[B2]	1.6E-08	3.0E-07	6%
Isophorone	3.5E-01	5.3E-01	3.1E-07	3.4E-06	0%	kidney; lesions	1000	[C]	5.0E-12	5.5E-11	0%
2-Methylnaphthalene	8.1E-01	1.5E+00	4.8E-06	6.6E-05	1%	skin effects	- -	- -			
4-Methyl-2-pentanone	5.0E-02	5.0E-02	1.1E-07	8.0E-07	0%	oral and inhal.-liver, kidney effects	3000	- -			
Naphthalene	4.2E-01	7.0E-01				dec. body weight	- -	[D]			
Pentachlorophenol	1.3E-01	1.3E-01	7.6E-07	5.6E-06	0%	liver, adrenal effects, fetotoxicity	100	[B2]	2.4E-10	1.7E-09	0%
Phenanthrene	2.1E+00	5.7E+00	1.2E-05	2.5E-04	2%	- -	- -	[D]			
Pyrene	2.8E+00	7.6E+00	1.6E-05	3.3E-04	3%	kidney; red. weight, renal tubular pathology	3000	[D]			
Xylenes	3.2E-01	6.4E-01	2.8E-08	4.1E-07	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 8.50E-04	RME 1.06E-02	100%						
Summed Cancer Risk									MLE 2.60E-07	RME 4.85E-06	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-16. RISK FROM VAPOR INHALATION BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Soil (mg/kg) MLE	RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	RME	RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	RME	RME % of total ELCR
INORGANICS											
Antimony	3.0E-01	5.3E-01				whole body, blood; inc. mortality	--	--			
Arsenic	9.8E+00	1.5E+01				skin; keratosis, hyperpigmentation	--	[A]			
Beryllium	3.5E-01	5.4E-01				no observed effects	--	[B2]			
Cadmium (food)	7.5E-01	1.2E+00				kidney; proteinuria	--	--			
Chromium (III)	1.3E+01	1.9E+01				no observed effects	--	--			
Copper	1.5E+01	2.0E+01				Gastrointestinal system; irritation	--	[D]			
Lead	3.4E+01	7.3E+01				CNS, blood	--	[B2]			
Mercury	5.5E-02	8.9E-02				oral-CNS; neurotoxicity. inhal.-kidney effects	30	[D]			
Nickel	1.4E+01	2.0E+01				dec. body and organ weight	--	--			
Silver	9.6E-01	1.3E+00				skin; argyria	--	[D]			
Thallium	2.0E-01	2.5E-01				liver, blood; inc. sgot and serum LDH	--	[D]			
Zinc	6.5E+01	1.1E+02				blood; anemia	--	[D]			
ORGANICS											
Acetone	1.6E-01	3.3E-01				inc. liver, kidney weights, nephrotoxicity	--	[D]			
Anthracene	2.7E-01	4.0E-01				no observed effects	--	[D]			
Benzene	1.4E-01	3.1E-01				--	--	[A]	5.6E-08	1.6E-07	100%
Benzo(a)anthracene	9.8E-01	2.5E+00				--	--	[B2]			
Benzo(a)pyrene	1.5E+00	3.9E+00				--	--	[B2]			
Benzo(b)fluoranthene	2.4E+00	6.6E+00				--	--	[B2]			
Benzo(g,h,i)perylene	1.1E+00	2.7E+00				--	--	[D]			
Benzo(k)fluoranthene	1.4E+00	3.7E+00				--	--	[B2]			
2-Butanone	1.9E-02	1.9E-02	7.5E-06	9.5E-06	1%	oral and inhal. - dec. fetal birth weight	1000	[D]			
Carbazole	6.2E-01	1.5E+00				--	--	[B2]			
Carbon Disulfide	4.0E-03	4.0E-03	2.3E-04	2.9E-04	43%	oral and inhal.-fetus; toxicity	1000	--			
Chrysene	2.1E+00	5.8E+00				--	--	[B2]			
Ethylbenzene	1.8E-01	3.4E-01	9.4E-05	2.3E-04	34%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	300	[D]			
Fluoranthene	3.4E+00	9.4E+00				kidney, liver, blood; inc. weight, hematological changes	--	[D]			
Indeno(1,2,3-cd)pyrene	1.4E+00	3.7E+00				--	--	[B2]			
Isophorone	3.5E-01	5.3E-01				kidney; lesions	--	[C]			
2-Methylnaphthalene	8.1E-01	1.5E+00				skin effects	--	--			
4-Methyl-2-pentanone	5.0E-02	5.0E-02	1.1E-04	1.4E-04	21%	oral and inhal.-liver, kidney effects	1000	--			
Naphthalene	4.2E-01	7.0E-01				dec. body weight	--	[D]			
Pentachlorophenol	1.3E-01	1.3E-01				liver, adrenal effects, fetotoxicity	--	[B2]			
Phenanthrene	2.1E+00	5.7E+00				--	--	[D]			
Pyrene	2.8E+00	7.6E+00				kidney; red. weight, renal tubular pathology	--	[D]			
Xylenes	3.2E-01	6.4E-01				CNS hyperactivity; dec. body weight	--	[D]			
Summed Hazard Quotient			MLE 4.43E-04	RME 6.77E-04	100%						
Summed Cancer Risk									MLE 5.59E-08	RME 1.58E-07	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-17. RISK FROM SOIL INGESTION BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Soil (mg/kg) MLE	Exposure Point Concentration in Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	3.0E-01	5.3E-01	8.0E-04	1.8E-03	2%	whole body, blood; inc. mortality	1000	- -			
Arsenic	9.8E+00	1.5E+01	3.5E-02	6.8E-02	82%	skin; keratosis, hyperpigmentation	3	[A]	2.4E-06	1.2E-05	38%
Beryllium	3.5E-01	5.4E-01	7.6E-05	1.5E-04	0%	no observed effects	100	[B2]	2.1E-07	1.1E-06	3%
Cadmium (food)	7.5E-01	1.2E+00	8.0E-04	1.7E-03	2%	kidney; proteinuria	10	- -			
Chromium (III)	1.3E+01	1.9E+01	1.4E-05	2.6E-05	0%	no observed effects	100	- -			
Copper	1.5E+01	2.0E+01	4.4E-04	7.4E-04	1%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.4E+01	7.3E+01				CNS, blood	- -	[B2]			
Mercury	5.5E-02	8.9E-02	2.0E-04	4.1E-04	0%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	1.4E+01	2.0E+01	7.6E-04	1.3E-03	2%	dec. body and organ weight	300	- -			
Silver	9.6E-01	1.3E+00	2.1E-04	3.5E-04	0%	skin; argyria	3	[D]			
Thallium	2.0E-01	2.5E-01	2.7E-03	4.4E-03	5%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	6.5E+01	1.1E+02	2.3E-04	4.9E-04	1%	blood; anemia	3	[D]			
ORGANICS											
Acetone	1.6E-01	3.3E-01	1.8E-06	4.5E-06	0%	inc. liver, kidney weights, nephrotoxicity	1000	[D]			
Anthracene	2.7E-01	4.0E-01	9.7E-07	1.8E-06	0%	no observed effects	3000	[D]			
Benzene	1.4E-01	3.1E-01	3.7E-04	1.1E-03	1%	- -	- -	[A]	5.6E-10	4.2E-09	0%
Benzo(a)anthracene	9.8E-01	2.5E+00	3.5E-05	1.1E-04	0%	- -	- -	[B2]	9.9E-08	8.4E-07	3%
Benzo(a)pyrene	1.5E+00	3.9E+00	5.2E-05	1.8E-04	0%	- -	- -	[B2]	1.5E-06	1.3E-05	41%
Benzo(b)fluoranthene	2.4E+00	6.6E+00	8.7E-05	3.0E-04	0%	- -	- -	[B2]	2.5E-07	2.3E-06	7%
Benzo(g,h,i)perylene	1.1E+00	2.7E+00	3.8E-05	1.2E-04	0%	- -	- -	[D]			
Benzo(k)fluoranthene	1.4E+00	3.7E+00	5.0E-05	1.7E-04	0%	- -	- -	[B2]	1.4E-07	1.3E-06	4%
2-Butanone	1.9E-02	1.9E-02	3.4E-08	4.3E-08	0%	oral and inhal. - dec. fetal birth weight	3000	[D]			
Carbazole	6.2E-01	1.5E+00				- -	- -	[B2]	1.7E-09	1.4E-08	0%
Carbon Disulfide	4.0E-03	4.0E-03	4.3E-08	5.5E-08	0%	oral and inhal.-fetus; toxicity	100	- -			
Chrysene	2.1E+00	5.8E+00	7.7E-05	2.6E-04	0%	- -	- -	[B2]	2.2E-08	2.0E-07	1%
Ethylbenzene	1.8E-01	3.4E-01	1.9E-06	4.7E-06	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	3.4E+00	9.4E+00	9.1E-05	3.2E-04	0%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Indeno(1,2,3-cd)pyrene	1.4E+00	3.7E+00	5.1E-05	1.7E-04	0%	- -	- -	[B2]	1.4E-07	1.3E-06	4%
Isophorone	3.5E-01	5.3E-01	1.9E-06	3.6E-06	0%	kidney; lesions	1000	[C]	4.6E-11	2.4E-10	0%
2-Methylnaphthalene	8.1E-01	1.5E+00	2.9E-05	7.0E-05	0%	skin effects	- -	- -			
4-Methyl-2-pentanone	5.0E-02	5.0E-02	6.7E-07	8.6E-07	0%	oral and inhal.-liver, kidney effects	3000	- -			
Naphthalene	4.2E-01	7.0E-01				dec. body weight	- -	[D]			
Pentachlorophenol	1.3E-01	1.3E-01	4.7E-06	5.9E-06	0%	liver, adrenal effects, fetotoxicity	100	[B2]	2.2E-09	7.3E-09	0%
Phenanthrene	2.1E+00	5.7E+00	7.4E-05	2.6E-04	0%	- -	- -	[D]			
Pyrene	2.8E+00	7.6E+00	1.0E-04	3.5E-04	0%	kidney; red. weight, renal tubular pathology	3000	[D]			
Xylenes	3.2E-01	6.4E-01	1.7E-07	4.4E-07	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 4.24E-02	RME 8.29E-02	100%						
Summed Cancer Risk									MLE 4.71E-06	RME 3.27E-05	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-18. RISK FROM SOIL INHALATION BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Soil (mg/kg) MLE	Exposure Point Concentration in Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (inhalation)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR RME	RME % of total ELCR
INORGANICS											
Antimony	3.0E-01	5.3E-01				whole body, blood; inc. mortality	--	--			
Arsenic	9.8E+00	1.5E+01				skin; keratosis, hyperpigmentation	--	[A]	2.9E-09	1.9E-08	98%
Beryllium	3.5E-01	5.4E-01				no observed effects	--	[B2]	1.8E-11	1.2E-10	1%
Cadmium (food)	7.5E-01	1.2E+00				kidney; proteinuria	--	--	2.7E-11	1.9E-10	1%
Chromium (III)	1.3E+01	1.9E+01				no observed effects	--	--			
Copper	1.5E+01	2.0E+01				Gastrointestinal system; irritation	--	[D]			
Lead	3.4E+01	7.3E+01				CNS, blood	--	[B2]			
Mercury	5.5E-02	8.9E-02	3.0E-08	6.1E-08	100%	oral-CNS; neurotoxicity. inhal.-kidney effects	30	[D]			
Nickel	1.4E+01	2.0E+01				dec. body and organ weight	--	--			
Silver	9.6E-01	1.3E+00				skin; argyria	--	[D]			
Thallium	2.0E-01	2.5E-01				liver, blood; inc. sgot and serum LDH	--	[D]			
Zinc	6.5E+01	1.1E+02				blood; anemia	--	[D]			
ORGANICS											
Acetone	1.6E-01	3.3E-01				inc. liver, kidney weights, nephrotoxicity	--	[D]			
Anthracene	2.7E-01	4.0E-01				no observed effects	--	[D]			
Benzene	1.4E-01	3.1E-01				--	--	[A]	2.4E-14	2.3E-13	0%
Benzo(a)anthracene	9.8E-01	2.5E+00				--	--	[B2]			
Benzo(a)pyrene	1.5E+00	3.9E+00				--	--	[B2]			
Benzo(b)fluoranthene	2.4E+00	6.6E+00				--	--	[B2]			
Benzo(g,h,i)perylene	1.1E+00	2.7E+00				--	--	[D]			
Benzo(k)fluoranthene	1.4E+00	3.7E+00				--	--	[B2]			
2-Butanone	1.9E-02	1.9E-02	3.1E-12	3.9E-12	0%	oral and inhal. - dec. fetal birth weight	1000	[D]			
Carbazole	6.2E-01	1.5E+00				--	--	[B2]			
Carbon Disulfide	4.0E-03	4.0E-03	6.5E-11	8.3E-11	0%	oral and inhal.-fetus; toxicity	1000	--			
Chrysene	2.1E+00	5.8E+00				--	--	[B2]			
Ethylbenzene	1.8E-01	3.4E-01	2.9E-11	7.1E-11	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	300	[D]			
Fluoranthene	3.4E+00	9.4E+00				kidney, liver, blood; inc. weight, hematological changes	--	[D]			
Indeno(1,2,3-cd)pyrene	1.4E+00	3.7E+00				--	--	[B2]			
Isophorone	3.5E-01	5.3E-01				kidney; lesions	--	[C]			
2-Methylnaphthalene	8.1E-01	1.5E+00				skin effects	--	--			
4-Methyl-2-pentanone	5.0E-02	5.0E-02	1.0E-10	1.3E-10	0%	oral and inhal.-liver, kidney effects	1000	--			
Naphthalene	4.2E-01	7.0E-01				dec. body weight	--	[D]			
Pentachlorophenol	1.3E-01	1.3E-01				liver, adrenal effects, fetotoxicity	--	[B2]			
Phenanthrene	2.1E+00	5.7E+00				--	--	[D]			
Pyrene	2.8E+00	7.6E+00				kidney; red. weight, renal tubular pathology	--	[D]			
Xylenes	3.2E-01	6.4E-01				CNS hyperactivity; dec. body weight	--	[D]			
Summed Hazard Quotient			MLE 2.98E-08	RME 6.17E-08	100%						
Summed Cancer Risk									MLE 2.97E-09	RME 1.92E-08	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-19. RISK FROM SOIL DERMAL CONTACT BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Soil (mg/kg)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Noncarcinogenic Effects: Target Organ System	UF (oral)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	3.0E-01	5.3E-01	8.0E-06	1.0E-04	2%	whole body, blood; inc. mortality	1000	- -			
Arsenic	9.8E+00	1.5E+01	3.5E-04	4.0E-03	60%	skin; keratosis, hyperpigmentation	3	[A]	2.4E-08	8.9E-07	6%
Beryllium	3.5E-01	5.4E-01	7.6E-07	8.6E-06	0%	no observed effects	100	[B2]	2.1E-09	8.0E-08	1%
Cadmium (food)	7.5E-01	1.2E+00	8.0E-06	9.7E-05	1%	kidney; proteinuria	10	- -			
Chromium (III)	1.3E+01	1.9E+01	1.4E-07	1.5E-06	0%	no observed effects	100	- -			
Copper	1.5E+01	2.0E+01	4.4E-06	4.3E-05	1%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.4E+01	7.3E+01				CNS, blood	- -	[B2]			
Mercury	5.5E-02	8.9E-02	2.0E-06	2.4E-05	0%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	1.4E+01	2.0E+01	7.6E-06	7.8E-05	1%	dec. body and organ weight	300	- -			
Silver	9.6E-01	1.3E+00	2.1E-06	2.0E-05	0%	skin; argyria	3	[D]			
Thallium	2.0E-01	2.5E-01	2.7E-05	2.5E-04	4%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	6.5E+01	1.1E+02	2.3E-06	2.8E-05	0%	blood; anemia	3	[D]			
ORGANICS											
Acetone	1.6E-01	3.3E-01	1.8E-07	2.6E-06	0%	inc. liver, kidney weights, nephrotoxicity	1000	[D]			
Anthracene	2.7E-01	4.0E-01	9.7E-08	1.1E-06	0%	no observed effects	3000	[D]			
Benzene	1.4E-01	3.1E-01	3.7E-05	6.1E-04	9%	- -	- -	[A]	5.6E-11	3.0E-09	0%
Benzo(a)anthracene	9.8E-01	2.5E+00	3.5E-06	6.5E-05	1%	- -	- -	[B2]	9.9E-09	6.1E-07	4%
Benzo(a)pyrene	1.5E+00	3.9E+00	5.2E-06	1.0E-04	2%	- -	- -	[B2]	1.5E-07	9.8E-06	65%
Benzo(b)fluoranthene	2.4E+00	6.6E+00	8.7E-06	1.7E-04	3%	- -	- -	[B2]	2.5E-08	1.6E-06	11%
Benzo(g,h,i)perylene	1.1E+00	2.7E+00	3.8E-06	7.1E-05	1%	- -	- -	[D]			
Benzo(k)fluoranthene	1.4E+00	3.7E+00	5.0E-06	9.8E-05	1%	- -	- -	[B2]	1.4E-08	9.2E-07	6%
2-Butanone	1.9E-02	1.9E-02	3.4E-09	2.5E-08	0%	oral and inhal. - dec. fetal birth weight	3000	[D]			
Carbazole	6.2E-01	1.5E+00				- -	- -	[B2]	1.7E-10	9.9E-09	0%
Carbon Disulfide	4.0E-03	4.0E-03	4.3E-09	3.2E-08	0%	oral and inhal.-fetus; toxicity	100	- -			
Chrysene	2.1E+00	5.8E+00	7.7E-06	1.5E-04	2%	- -	- -	[B2]	2.2E-09	1.4E-07	1%
Ethylbenzene	1.8E-01	3.4E-01	1.9E-07	2.7E-06	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	3.4E+00	9.4E+00	9.1E-06	1.9E-04	3%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Indeno(1,2,3-cd)pyrene	1.4E+00	3.7E+00	5.1E-06	9.9E-05	1%	- -	- -	[B2]	1.4E-08	9.2E-07	6%
Isophorone	3.5E-01	5.3E-01	1.9E-07	2.1E-06	0%	kidney; lesions	1000	[C]	4.6E-12	1.7E-10	0%
2-Methylnaphthalene	8.1E-01	1.5E+00	2.9E-06	4.1E-05	1%	skin effects	- -	- -			
4-Methyl-2-pentanone	5.0E-02	5.0E-02	6.7E-08	5.0E-07	0%	oral and inhal.-liver, kidney effects	3000	- -			
Naphthalene	4.2E-01	7.0E-01				dec. body weight	- -	[D]			
Pentachlorophenol	1.3E-01	1.3E-01	4.7E-07	3.4E-06	0%	liver, adrenal effects, fetotoxicity	100	[B2]	2.2E-10	5.3E-09	0%
Phenanthrene	2.1E+00	5.7E+00	7.4E-06	1.5E-04	2%	- -	- -	[D]			
Pyrene	2.8E+00	7.6E+00	1.0E-05	2.0E-04	3%	kidney; red. weight, renal tubular pathology	3000	[D]			
Xylenes	3.2E-01	6.4E-01	1.7E-08	2.5E-07	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 5.20E-04	RME 6.58E-03	100%						
Summed Cancer Risk									MLE 2.39E-07	RME 1.50E-05	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-20. RISK FROM VAPOR INHALATION BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Soil (mg/kg) MLE	Exposure Point Concentration in Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (inhalation)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR RME	RME % of total ELCR
INORGANICS											
Antimony	3.0E-01	5.3E-01				whole body, blood; inc. mortality	--	--			
Arsenic	9.8E+00	1.5E+01				skin; keratosis, hyperpigmentation	--	[A]			
Beryllium	3.5E-01	5.4E-01				no observed effects	--	[B2]			
Cadmium (food)	7.5E-01	1.2E+00				kidney; proteinuria	--	--			
Chromium (III)	1.3E+01	1.9E+01				no observed effects	--	--			
Copper	1.5E+01	2.0E+01				Gastrointestinal system; irritation	--	[D]			
Lead	3.4E+01	7.3E+01				CNS, blood	--	[B2]			
Mercury	5.5E-02	8.9E-02				oral-CNS; neurotoxicity. inhal.-kidney effects	30	[D]			
Nickel	1.4E+01	2.0E+01				dec. body and organ weight	--	--			
Silver	9.6E-01	1.3E+00				skin; argyria	--	[D]			
Thallium	2.0E-01	2.5E-01				liver, blood; inc. sgot and serum LDH	--	[D]			
Zinc	6.5E+01	1.1E+02				blood; anemia	--	[D]			
ORGANICS											
Acetone	1.6E-01	3.3E-01				inc. liver, kidney weights, nephrotoxicity	--	[D]			
Anthracene	2.7E-01	4.0E-01				no observed effects	--	[D]			
Benzene	1.4E-01	3.1E-01				--	--	[A]	1.8E-08	1.7E-07	100%
Benzo(a)anthracene	9.8E-01	2.5E+00				--	--	[B2]			
Benzo(a)pyrene	1.5E+00	3.9E+00				--	--	[B2]			
Benzo(b)fluoranthene	2.4E+00	6.6E+00				--	--	[B2]			
Benzo(g,h,i)perylene	1.1E+00	2.7E+00				--	--	[D]			
Benzo(k)fluoranthene	1.4E+00	3.7E+00				--	--	[B2]			
2-Butanone	1.9E-02	1.9E-02	1.6E-06	2.0E-06	1%	oral and inhal. - dec. fetal birth weight	1000	[D]			
Carbazole	6.2E-01	1.5E+00				--	--	[B2]			
Carbon Disulfide	4.0E-03	4.0E-03	4.9E-05	6.3E-05	43%	oral and inhal.-fetus; toxicity	1000	--			
Chrysene	2.1E+00	5.8E+00				--	--	[B2]			
Ethylbenzene	1.8E-01	3.4E-01	2.0E-05	5.0E-05	34%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	300	[D]			
Fluoranthene	3.4E+00	9.4E+00				kidney, liver, blood; inc. weight, hematological changes	--	[D]			
Indeno(1,2,3-cd)pyrene	1.4E+00	3.7E+00				--	--	[B2]			
Isophorone	3.5E-01	5.3E-01				kidney; lesions	--	[C]			
2-Methylnaphthalene	8.1E-01	1.5E+00				skin effects	--	--			
4-Methyl-2-pentanone	5.0E-02	5.0E-02	2.4E-05	3.1E-05	21%	oral and inhal.-liver, kidney effects	1000	--			
Naphthalene	4.2E-01	7.0E-01				dec. body weight	--	[D]			
Pentachlorophenol	1.3E-01	1.3E-01				liver, adrenal effects, fetotoxicity	--	[B2]			
Phenanthrene	2.1E+00	5.7E+00				--	--	[D]			
Pyrene	2.8E+00	7.6E+00				kidney; red. weight, renal tubular pathology	--	[D]			
Xylenes	3.2E-01	6.4E-01				CNS hyperactivity; dec. body weight	--	[D]			
Summed Hazard Quotient			MLE 9.50E-05	RME 1.45E-04	100%						
Summed Cancer Risk									MLE 1.80E-08	RME 1.69E-07	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-21. RISK FROM GROUNDWATER INGESTION BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l) MLE	Exposure Point Concentration in Groundwater (mg/l) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR RME	RME % of total ELCR
INORGANICS											
Antimony	1.7E-03	3.0E-03	2.1E-01	4.8E-01	2%	whole body, blood; inc. mortality	1000	- -			
Arsenic	3.1E-02	7.8E-02	5.2E+00	1.7E+01	81%	skin; keratosis, hyperpigmentation	3	[A]	2.3E-04	7.5E-04	76%
Beryllium	5.4E-03	1.0E-02	5.4E-02	1.3E-01	1%	no observed effects	100	[B2]	1.0E-04	2.4E-04	24%
Chromium (III)	2.3E-01	3.5E-01	1.2E-02	2.2E-02	0%	no observed effects	100	- -			
Copper	3.1E-01	5.8E-01	4.2E-01	1.0E+00	5%	Gastrointestinal system; irritation	- -	[D]			
Lead	1.2E-01	2.0E-01				CNS, blood	- -	[B2]			
Nickel	2.9E-01	5.6E-01	7.4E-01	1.8E+00	9%	dec. body and organ weight	300	- -			
Silver	8.3E-03	2.0E-02	8.3E-02	2.5E-01	1%	skin; argyria	3	[D]			
Zinc	8.5E-01	1.5E+00	1.4E-01	3.1E-01	2%	blood; anemia	3	[D]			
ORGANICS											
Tetrachloroethylene	2.0E-04	2.0E-04	1.0E-03	1.3E-03	0%	liver; hepatotoxicity	1000	- -			
Summed Hazard Quotient			MLE 6.86E+00	RME 2.06E+01	100%						
Summed Cancer Risk									MLE 3.34E-04	RME 9.91E-04	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-22. RISK FROM FILTERED GROUNDWATER INGESTION BY RESIDENT CHILD - FUTURE CONDITIONS SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l) MLE	Exposure Point Concentration in Groundwater (mg/l) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony (d)	1.0E-03	1.5E-03	1.3E-01	2.4E-01	34%	whole body, blood; inc. mortality	1000	- -			
Arsenic (d)	1.8E-03	2.1E-03	3.0E-01	4.5E-01	64%	skin; keratosis, hyperpigmentation	3	[A]	1.4E-05	2.0E-05	100%
Zinc (d)	3.2E-02	5.4E-02	5.3E-03	1.2E-02	2%	blood; anemia	3	[D]			
Summed Hazard Quotient			MLE 4.32E-01	RME 6.99E-01	100%						
Summed Cancer Risk									MLE 1.36E-05	RME 2.01E-05	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-23. RISK FROM GROUNDWATER INHALATION BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l) MLE	Exposure Point Concentration in Groundwater (mg/l) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	1.7E-03	3.0E-03				whole body, blood; inc. mortality	--	--			
Arsenic	3.1E-02	7.8E-02				skin; keratosis, hyperpigmentation	--	[A]			
Beryllium	5.4E-03	1.0E-02				no observed effects	--	[B2]			
Chromium (III)	2.3E-01	3.5E-01				no observed effects	--	--			
Copper	3.1E-01	5.8E-01				Gastrointestinal system; irritation	--	[D]			
Lead	1.2E-01	2.0E-01				CNS, blood	--	[B2]			
Nickel	2.9E-01	5.6E-01				dec. body and organ weight	--	--			
Silver	8.3E-03	2.0E-02				skin; argyria	--	[D]			
Zinc	8.5E-01	1.5E+00				blood; anemia	--	[D]			
ORGANICS											
Tetrachloroethylene	2.0E-04	2.0E-04				liver; hepatotoxicity	--	--			
Summed Hazard Quotient			MLE --	RME --							
Summed Cancer Risk									MLE --	RME --	

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-24. RISK FROM FILTERED GROUNDWATER INHALATION BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l) MLE	Exposure Point Concentration in Groundwater (mg/l) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (inhalation)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony (d)	1.0E-03	1.5E-03				whole body, blood; inc. mortality	--	--			
Arsenic (d)	1.8E-03	2.1E-03				skin; keratosis, hyperpigmentation	--	[A]			
Zinc (d)	3.2E-02	5.4E-02				blood; anemia	--	[D]			
Summed Hazard Quotient			MLE --	RME --							
Summed Cancer Risk									MLE --	RME --	

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-25. RISK FROM GROUNDWATER DERMAL CONTACT BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	1.7E-03	3.0E-03	1.7E-04	6.4E-04	3%	whole body, blood; inc. mortality	1000	- -			
Arsenic	3.1E-02	7.8E-02	4.2E-03	2.2E-02	88%	skin; keratosis, hyperpigmentation	3	[A]	2.2E-06	1.2E-05	76%
Beryllium	5.4E-03	1.0E-02	4.4E-05	1.8E-04	1%	no observed effects	100	[B2]	9.5E-07	3.8E-06	24%
Chromium (III)	2.3E-01	3.5E-01	1.9E-05	5.9E-05	0%	no observed effects	100	- -			
Copper	3.1E-01	5.8E-01	3.4E-04	1.3E-03	5%	Gastrointestinal system; irritation	- -	[D]			
Lead	1.2E-01	2.0E-01				CNS, blood	- -	[B2]			
Nickel	2.9E-01	5.6E-01	6.0E-05	2.4E-04	1%	dec. body and organ weight	300	- -			
Silver	8.3E-03	2.0E-02	6.8E-05	3.3E-04	1%	skin; argyria	3	[D]			
Zinc	8.5E-01	1.5E+00	7.0E-05	2.5E-04	1%	blood; anemia	3	[D]			
ORGANICS											
Tetrachloroethylene	2.0E-04	2.0E-04	3.9E-05	8.2E-05	0%	liver; hepatotoxicity	1000	- -			
Summed Hazard Quotient			MLE 5.06E-03	RME 2.53E-02	100%						
Summed Cancer Risk									MLE 3.18E-06	RME 1.54E-05	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-26. RISK FROM FILTERED GROUNDWATER DERMAL CONTACT BY RESIDENT CHILD - FUTURE CONDITIONS SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony (d)	1.0E-03	1.5E-03	1.0E-04	3.2E-04	35%	whole body, blood; inc. mortality	1000	- -			
Arsenic (d)	1.8E-03	2.1E-03	2.5E-04	6.0E-04	64%	skin; keratosis, hyperpigmentation	3	[A]	1.3E-07	3.1E-07	100%
Zinc (d)	3.2E-02	5.4E-02	2.6E-06	9.2E-06	1%	blood; anemia	3	[D]			

Summed Hazard Quotient	MLE	RME	
	3.51E-04	9.26E-04	100%

Summed Cancer Risk	MLE	RME	
	1.29E-07	3.13E-07	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-27. RISK FROM GROUNDWATER INGESTION BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	1.7E-03	3.0E-03	6.4E-02	2.1E-01	2%	whole body, blood; inc. mortality	1000	- -			
Arsenic	3.1E-02	7.8E-02	1.6E+00	7.1E+00	81%	skin; keratosis, hyperpigmentation	3	[A]	1.1E-04	1.6E-03	76%
Beryllium	5.4E-03	1.0E-02	1.6E-02	5.6E-02	1%	no observed effects	100	[B2]	4.5E-05	5.2E-04	24%
Chromium (III)	2.3E-01	3.5E-01	3.5E-03	9.5E-03	0%	no observed effects	100	- -			
Copper	3.1E-01	5.8E-01	1.3E-01	4.3E-01	5%	Gastrointestinal system; irritation	- -	[D]			
Lead	1.2E-01	2.0E-01				CNS, blood	- -	[B2]			
Nickel	2.9E-01	5.6E-01	2.2E-01	7.7E-01	9%	dec. body and organ weight	300	- -			
Silver	8.3E-03	2.0E-02	2.5E-02	1.1E-01	1%	skin; argyria	3	[D]			
Zinc	8.5E-01	1.5E+00	4.3E-02	1.3E-01	2%	blood; anemia	3	[D]			
ORGANICS											
Tetrachloroethylene	2.0E-04	2.0E-04	3.0E-04	5.5E-04	0%	liver; hepatotoxicity	1000	- -			
Summed Hazard Quotient			MLE 2.06E+00	RME 8.84E+00	100%						
Summed Cancer Risk									MLE 1.50E-04	RME 2.12E-03	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-28. RISK FROM FILTERED GROUNDWATER INGESTION BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony (d)	1.0E-03	1.5E-03	3.8E-02	1.0E-01	34%	whole body, blood; inc. mortality	1000	- -			
Arsenic (d)	1.8E-03	2.1E-03	9.0E-02	1.9E-01	64%	skin; keratosis, hyperpigmentation	3	[A]	6.1E-06	4.3E-05	100%
Zinc (d)	3.2E-02	5.4E-02	1.6E-03	4.9E-03	2%	blood; anemia	3	[D]			
Summed Hazard Quotient			MLE 1.30E-01	RME 2.99E-01	100%						
Summed Cancer Risk									MLE 6.10E-06	RME 4.32E-05	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-29. RISK FROM GROUNDWATER INHALATION BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l) MLE	Exposure Point Concentration in Groundwater (mg/l) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR RME	RME % of total ELCR
INORGANICS											
Antimony	1.7E-03	3.0E-03				whole body, blood; inc. mortality	--	--			
Arsenic	3.1E-02	7.8E-02				skin; keratosis, hyperpigmentation	--	[A]			
Beryllium	5.4E-03	1.0E-02				no observed effects	--	[B2]			
Chromium (III)	2.3E-01	3.5E-01				no observed effects	--	--			
Copper	3.1E-01	5.8E-01				Gastrointestinal system; irritation	--	[D]			
Lead	1.2E-01	2.0E-01				CNS, blood	--	[B2]			
Nickel	2.9E-01	5.6E-01				dec. body and organ weight	--	--			
Silver	8.3E-03	2.0E-02				skin; argyria	--	[D]			
Zinc	8.5E-01	1.5E+00				blood; anemia	--	[D]			
ORGANICS											
Tetrachloroethylene	2.0E-04	2.0E-04				liver; hepatotoxicity	--	--			

	MLE	RME
Summed Hazard Quotient	--	--

	MLE	RME
Summed Cancer Risk	--	--

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-30. RISK FROM FILTERED GROUNDWATER INHALATION BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l) MLE	Exposure Point Concentration in Groundwater (mg/l) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (inhalation)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR RME	RME % of total ELCR
INORGANICS											
Antimony (d)	1.0E-03	1.5E-03				whole body, blood; inc. mortality	--	--			
Arsenic (d)	1.8E-03	2.1E-03				skin; keratosis, hyperpigmentation	--	[A]			
Zinc (d)	3.2E-02	5.4E-02				blood; anemia	--	[D]			
Summed Hazard Quotient			MLE --	RME --							
Summed Cancer Risk									MLE --	RME --	

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-31. RISK FROM GROUNDWATER DERMAL CONTACT BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	1.7E-03	3.0E-03	1.1E-04	3.4E-04	3%	whole body, blood; inc. mortality	1000	- -			
Arsenic	3.1E-02	7.8E-02	2.6E-03	1.2E-02	88%	skin; keratosis, hyperpigmentation	3	[A]	1.4E-06	6.2E-06	76%
Beryllium	5.4E-03	1.0E-02	2.7E-05	9.4E-05	1%	no observed effects	100	[B2]	5.8E-07	2.0E-06	24%
Chromium (III)	2.3E-01	3.5E-01	1.2E-05	3.2E-05	0%	no observed effects	100	- -			
Copper	3.1E-01	5.8E-01	2.1E-04	7.2E-04	5%	Gastrointestinal system; irritation	- -	[D]			
Lead	1.2E-01	2.0E-01				CNS, blood	- -	[B2]			
Nickel	2.9E-01	5.6E-01	3.7E-05	1.3E-04	1%	dec. body and organ weight	300	- -			
Silver	8.3E-03	2.0E-02	4.2E-05	1.8E-04	1%	skin; argyria	3	[D]			
Zinc	8.5E-01	1.5E+00	4.3E-05	1.3E-04	1%	blood; anemia	3	[D]			
ORGANICS											
Tetrachloroethylene	2.0E-04	2.0E-04	2.4E-05	4.4E-05	0%	liver; hepatotoxicity	1000	- -			
Summed Hazard Quotient			MLE 3.10E-03	RME 1.35E-02	100%						
Summed Cancer Risk									MLE 1.95E-06	RME 8.26E-06	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-32. RISK FROM FILTERED GROUNDWATER DERMAL CONTACT BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 2 - FIRE TRAINING AREA 2, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony (d)	1.0E-03	1.5E-03	6.3E-05	1.7E-04	35%	whole body, blood; inc. mortality	1000	- -			
Arsenic (d)	1.8E-03	2.1E-03	1.5E-04	3.2E-04	64%	skin; keratosis, hyperpigmentation	3	[A]	7.9E-08	1.7E-07	100%
Zinc (d)	3.2E-02	5.4E-02	1.6E-06	4.9E-06	1%	blood; anemia	3	[D]			
Summed Hazard Quotient			MLE 2.15E-04	RME 4.96E-04	100%						
Summed Cancer Risk									MLE 7.91E-08	RME 1.68E-07	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

Table H-33. Risk Estimate Summary - RME Risks
Site 3 - Leach Field
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

CURRENT - OCCUPATIONAL

MEDIA	ROUTE	BASE PERSONNEL				CONSTRUCTION WORKER			
		Noncancer		Cancer		Noncancer		Cancer	
Soil	Ingestion	1.6E-02	B	4.0E-06	W	2.2E-01	B	3.9E-06	W
	Dermal	1.0E-03	B	8.3E-07	B	2.8E-03	B	1.7E-07	B
Soil Total	**Combined**	**1.7E-02**	B	**4.8E-06**	W	**2.2E-01**	B	**4.0E-06**	W

TOTAL	**1.7E-02**	B	**4.8E-06**	W	**2.2E-01**	B	**4.0E-06**	W

FUTURE - RESIDENTIAL

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Soil	Ingestion	5.9E-01	B	3.1E-05	W	6.3E-02	B	1.3E-05	W
	Inhalation	3.9E-07	B	1.3E-08	B	8.3E-08	B	1.4E-08	B
	Dermal	6.3E-03	B	1.1E-06	W	3.9E-03	B	3.5E-06	W
Soil Total	**Combined**	**6.0E-01**	B	**3.3E-05**	W	**6.7E-02**	B	**1.7E-05**	W

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Air (vapors) Total	**Inhalation**	**1.9E-04**	B	--	--	**4.1E-05**	B	--	--

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Groundwater	Ingestion	1.2E+01	E	5.1E-04	E	5.0E+00	E	1.1E-03	E
	Inhalation	--	--	--	--	--	--	--	--
	Dermal	1.5E-02	B	2.0E-07	B	8.0E-03	B	5.3E-07	B
GW Total	**Combined**	**1.2E+01**	E	**5.1E-04**	E	**5.0E+00**	E	**1.1E-03**	E

TOTAL	**1.2E+01**	E	**5.4E-04**	E	**5.1E+00**	E	**1.1E-03**	E

"B" - Below EPA human noncancer health effects target (HI < 1) or cancer risk (ELCR < 1 x 10-6)
"W" - Within EPA target cancer risk range (ELCR <= 1 x 10-4 and >= 1 x 10-6)
"E" - Exceeds EPA human noncancer health effects target (HI > 1) or cancer risks (ELCR > 1 x 10E-4)
-- No results are available for this route because detected chemicals do not easily volatilize and/or have no EPA-approved toxicity values

TABLE H-34. RISK FROM SOIL INGESTION BY BASE PERSONNEL - CURRENT CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		Noncarcinogenic Effects: RME % of total HQ	Noncarcinogenic Effects: Target Organ System	Noncarcinogenic Effects: UF (oral)	Carcinogenic Effects: WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		Carcinogenic Effects: RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Arsenic	8.8E+00	1.1E+01	2.9E-03	1.4E-02	85%	skin; keratosis, hyperpigmentation	3	[A]	5.4E-07	2.6E-06	65%
Beryllium	3.8E-01	4.5E-01	7.5E-06	3.5E-05	0%	no observed effects	100	[B2]	5.7E-08	2.7E-07	7%
Cadmium (food)	2.0E-01	2.8E-01	2.0E-05	1.1E-04	1%	kidney; proteinuria	10				
Chromium (III)	1.6E+01	2.3E+01	1.6E-06	9.0E-06	0%	no observed effects	100				
Copper	2.8E+01	4.5E+01	7.3E-05	4.7E-04	3%	Gastrointestinal system; irritation	--	[D]			
Lead	2.6E+01	3.9E+01				CNS, blood	--	[B2]			
Nickel	2.0E+01	2.3E+01	9.5E-05	4.5E-04	3%	dec. body and organ weight	300				
Thallium	1.2E-01	1.9E-01	1.5E-04	9.1E-04	6%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	1.3E+02	2.3E+02	4.2E-05	3.0E-04	2%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthene	3.5E-02	3.5E-02	5.7E-08	2.3E-07	0%	liver; hepatotoxicity	3000				
Anthracene	1.3E-01	1.3E-01	4.2E-08	1.7E-07	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	3.9E-01	6.8E-01	1.3E-06	8.8E-06	0%	--	--	[B2]	9.8E-09	6.9E-08	2%
Benzo(a)pyrene	3.8E-01	6.6E-01	1.3E-06	8.6E-06	0%	--	--	[B2]	9.8E-08	6.7E-07	17%
Benzo(b)fluoranthene	5.6E-01	9.6E-01	1.8E-06	1.3E-05	0%	--	--	[B2]	1.4E-08	9.8E-08	2%
Benzo(g,h,i)perylene	3.1E-01	4.8E-01	9.9E-07	6.3E-06	0%	--	--	[D]			
Benzo(k)fluoranthene	2.3E-01	3.7E-01	7.7E-07	4.8E-06	0%	--	--	[B2]	6.0E-09	3.7E-08	1%
Carbazole	7.5E-02	7.5E-02				--	--	[B2]	5.2E-11	2.1E-10	0%
Chrysene	4.6E-01	7.8E-01	1.5E-06	1.0E-05	0%	--	--	[B2]	1.2E-09	8.0E-09	0%
Fluoranthene	9.4E-01	1.7E+00	2.3E-06	1.7E-05	0%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Fluorene	5.1E-02	5.1E-02	1.2E-07	5.0E-07	0%	erythrocytes; dec. counts	3000	[D]			
Indeno(1,2,3-cd)pyrene	3.7E-01	6.1E-01	1.2E-06	7.9E-06	0%	--	--	[B2]	9.5E-09	6.2E-08	2%
N-nitroso-di-n-propylamine	2.0E-01	2.0E-01				--	--	[B2]	5.0E-08	2.0E-07	5%
Phenanthrene	3.5E-01	6.4E-01	1.2E-06	8.4E-06	0%	--	--	[D]			
Pyrene	1.1E+00	2.0E+00	3.5E-06	2.6E-05	0%	kidney; red. weight, renal tubular pathology	3000	[D]			
Toluene	3.8E-03	3.8E-03	1.9E-09	7.4E-09	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	1000	[D]			

Summed Hazard Quotient	MLE	RME	
	3.27E-03	1.63E-02	100%

Summed Cancer Risk	MLE	RME	
	7.82E-07	4.02E-06	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-35. RISK FROM SOIL DERMAL CONTACT BY BASE PERSONNEL - CURRENT CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg) MLE	Exposure Point Concentration in Surface Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR RME	RME % of total ELCR
INORGANICS											
Arsenic	8.8E+00	1.1E+01	5.7E-05	8.1E-04	80%	skin; keratosis, hyperpigmentation	3	[A]	1.1E-08	1.5E-07	18%
Beryllium	3.8E-01	4.5E-01	1.5E-07	2.0E-06	0%	no observed effects	100	[B2]	1.1E-09	1.6E-08	2%
Cadmium (food)	2.0E-01	2.8E-01	4.0E-07	6.4E-06	1%	kidney; proteinuria	10				
Chromium (III)	1.6E+01	2.3E+01	3.2E-08	5.2E-07	0%	no observed effects	100				
Copper	2.8E+01	4.5E+01	1.5E-06	2.7E-05	3%	Gastrointestinal system; irritation	--	[D]			
Lead	2.6E+01	3.9E+01				CNS, blood	--	[B2]			
Nickel	2.0E+01	2.3E+01	1.9E-06	2.6E-05	3%	dec. body and organ weight	300				
Thallium	1.2E-01	1.9E-01	3.0E-06	5.3E-05	5%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	1.3E+02	2.3E+02	8.3E-07	1.7E-05	2%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthene	3.5E-02	3.5E-02	1.1E-08	1.3E-07	0%	liver; hepatotoxicity	3000				
Anthracene	1.3E-01	1.3E-01	8.5E-09	9.8E-08	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	3.9E-01	6.8E-01	2.5E-07	5.1E-06	1%	--	--	[B2]	2.0E-09	4.0E-08	5%
Benzo(a)pyrene	3.8E-01	6.6E-01	2.5E-07	5.0E-06	0%	--	--	[B2]	2.0E-08	3.9E-07	47%
Benzo(b)fluoranthene	5.6E-01	9.6E-01	3.6E-07	7.3E-06	1%	--	--	[B2]	2.8E-09	5.7E-08	7%
Benzo(g,h,i)perylene	3.1E-01	4.8E-01	2.0E-07	3.7E-06	0%	--	--	[D]			
Benzo(k)fluoranthene	2.3E-01	3.7E-01	1.5E-07	2.8E-06	0%	--	--	[B2]	1.2E-09	2.2E-08	3%
Carbazole	7.5E-02	7.5E-02				--	--	[B2]	1.0E-11	1.2E-10	0%
Chrysene	4.6E-01	7.8E-01	3.0E-07	5.9E-06	1%	--	--	[B2]	2.3E-10	4.6E-09	1%
Fluoranthene	9.4E-01	1.7E+00	4.6E-07	9.8E-06	1%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Fluorene	5.1E-02	5.1E-02	2.5E-08	2.9E-07	0%	erythrocytes; dec. counts	3000	[D]			
Indeno(1,2,3-cd)pyrene	3.7E-01	6.1E-01	2.4E-07	4.6E-06	0%	--	--	[B2]	1.9E-09	3.6E-08	4%
N-nitroso-di-n-propylamine	2.0E-01	2.0E-01				--	--	[B2]	9.9E-09	1.1E-07	14%
Phenanthrene	3.5E-01	6.4E-01	2.3E-07	4.8E-06	0%	--	--	[D]			
Pyrene	1.1E+00	2.0E+00	7.0E-07	1.5E-05	1%	kidney; red. weight, renal tubular pathology	3000	[D]			
Toluene	3.8E-03	3.8E-03	3.7E-10	4.3E-09	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	1000	[D]			
Summed Hazard Quotient			MLE 6.82E-05	RME 1.00E-03	100%						
Summed Cancer Risk									MLE 4.95E-08	RME 8.29E-07	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-36. RISK FROM SOIL INGESTION BY CONSTRUCTION WORKER - CURRENT CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Construction Zone Soil (mg/kg) MLE	RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	RME	RME % of total ELCR
INORGANICS											
Antimony	1.1E-01	1.6E-01	5.1E-04	1.9E-03	1%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.8E+00	1.1E+01	5.7E-02	1.7E-01	77%	skin; keratosis, hyperpigmentation	3	[A]	8.6E-07	2.5E-06	65%
Beryllium	3.8E-01	4.5E-01	1.5E-04	4.2E-04	0%	no observed effects	100	[B2]	9.2E-08	2.6E-07	7%
Cadmium (food)	4.3E-01	6.8E-01	8.4E-04	3.2E-03	1%	kidney; proteinuria	10	- -			
Chromium (III)	3.0E+01	3.6E+01	5.9E-05	1.7E-04	0%	no observed effects	100	- -			
Copper	2.8E+01	4.5E+01	1.5E-03	5.7E-03	3%	Gastrointestinal system; irritation	- -	[D]			
Lead	2.8E+01	4.7E+01				CNS, blood	- -	[B2]			
Mercury	6.5E-02	1.2E-01	4.2E-04	1.9E-03	1%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	2.0E+01	2.3E+01	1.9E-03	5.4E-03	2%	dec. body and organ weight	300	- -			
Selenium	1.1E-01	1.8E-01	4.2E-05	1.7E-04	0%	whole body; clinical selenosis	3	[D]			
Silver	8.6E+00	1.6E+01	3.4E-03	1.5E-02	7%	skin; argyria	3	[D]			
Thallium	1.2E-01	1.9E-01	3.0E-03	1.1E-02	5%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	1.3E+02	2.3E+02	8.3E-04	3.6E-03	2%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthene	3.5E-02	3.5E-02	1.1E-06	2.7E-06	0%	liver; hepatotoxicity	3000	- -			
Anthracene	1.3E-01	1.3E-01	8.5E-07	2.0E-06	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	3.9E-01	6.8E-01	2.5E-05	1.1E-04	0%	- -	- -	[B2]	1.6E-08	6.6E-08	2%
Benzo(a)pyrene	3.8E-01	6.6E-01	2.5E-05	1.0E-04	0%	- -	- -	[B2]	1.6E-07	6.4E-07	17%
Benzo(b)fluoranthene	5.6E-01	9.6E-01	3.6E-05	1.5E-04	0%	- -	- -	[B2]	2.3E-08	9.4E-08	2%
Benzo(g,h,i)perylene	3.1E-01	4.8E-01	2.0E-05	7.6E-05	0%	- -	- -	[D]			
Benzo(k)fluoranthene	2.3E-01	3.7E-01	1.5E-05	5.7E-05	0%	- -	- -	[B2]	9.6E-09	3.6E-08	1%
Carbazole	7.5E-02	7.5E-02				- -	- -	[B2]	8.4E-11	2.0E-10	0%
Carbon Disulfide	2.0E-03	2.0E-03	3.9E-08	9.4E-08	0%	oral and inhal.-fetus; toxicity	100	- -			
Chrysene	4.6E-01	7.8E-01	3.0E-05	1.2E-04	0%	- -	- -	[B2]	1.9E-09	7.7E-09	0%
Di-n-octyl phthalate	4.4E-02	4.4E-02	4.3E-06	1.0E-05	0%	kidney, liver; inc. weight, inc. sgot and sgpt activity	1000	- -			
Ethylbenzene	1.0E-02	1.0E-02	2.0E-07	4.7E-07	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	9.4E-01	1.7E+00	4.6E-05	2.0E-04	0%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Fluorene	9.6E-02	9.6E-02	4.7E-06	1.1E-05	0%	erythrocytes; dec. counts	3000	[D]			
Indeno(1,2,3-cd)pyrene	3.7E-01	6.1E-01	2.4E-05	9.5E-05	0%	- -	- -	[B2]	1.5E-08	6.0E-08	2%
2-Methylnaphthalene	1.5E-01	2.1E-01	9.8E-06	3.3E-05	0%	skin effects	- -	- -			
N-nitroso-di-n-propylamine	2.0E-01	2.0E-01				- -	- -	[B2]	7.9E-08	1.9E-07	5%
Phenanthrene	3.5E-01	6.4E-01	2.3E-05	1.0E-04	0%	- -	- -	[D]			
Pyrene	1.1E+00	2.0E+00	7.0E-05	3.1E-04	0%	kidney; red. weight, renal tubular pathology	3000	[D]			
Toluene	3.8E-03	3.8E-03	3.7E-08	8.9E-08	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	1000	[D]			
Xylenes	3.4E-02	8.0E-02	3.3E-08	1.9E-07	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 7.02E-02	RME 2.17E-01	100%						
Summed Cancer Risk									MLE 1.25E-06	RME 3.86E-06	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-37. RISK FROM SOIL DERMAL CONTACT BY CONSTRUCTION WORKER - CURRENT CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Construction Zone Soil (mg/kg)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	1.1E-01	1.6E-01	2.6E-06	2.3E-05	1%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.8E+00	1.1E+01	2.9E-04	2.0E-03	73%	skin; keratosis, hyperpigmentation	3	[A]	4.3E-09	3.0E-08	18%
Beryllium	3.8E-01	4.5E-01	7.5E-07	5.1E-06	0%	no observed effects	100	[B2]	4.6E-10	3.1E-09	2%
Cadmium (food)	4.3E-01	6.8E-01	4.2E-06	3.9E-05	1%	kidney; proteinuria	10	- -			
Chromium (III)	3.0E+01	3.6E+01	2.9E-07	2.0E-06	0%	no observed effects	100	- -			
Copper	2.8E+01	4.5E+01	7.3E-06	6.9E-05	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	2.8E+01	4.7E+01				CNS, blood	- -	[B2]			
Mercury	6.5E-02	1.2E-01	2.1E-06	2.3E-05	1%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	2.0E+01	2.3E+01	9.5E-06	6.5E-05	2%	dec. body and organ weight	300	- -			
Selenium	1.1E-01	1.8E-01	2.1E-07	2.0E-06	0%	whole body; clinical selenosis	3	[D]			
Silver	8.6E+00	1.6E+01	1.7E-05	1.9E-04	7%	skin; argyria	3	[D]			
Thallium	1.2E-01	1.9E-01	1.5E-05	1.3E-04	5%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	1.3E+02	2.3E+02	4.2E-06	4.3E-05	2%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthene	3.5E-02	3.5E-02	5.7E-08	3.3E-07	0%	liver; hepatotoxicity	3000	- -			
Anthracene	1.3E-01	1.3E-01	4.2E-08	2.5E-07	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	3.9E-01	6.8E-01	1.3E-06	1.3E-05	0%	- -	- -	[B2]	7.9E-10	8.0E-09	5%
Benzo(a)pyrene	3.8E-01	6.6E-01	1.3E-06	1.2E-05	0%	- -	- -	[B2]	7.8E-09	7.8E-08	47%
Benzo(b)fluoranthene	5.6E-01	9.6E-01	1.8E-06	1.8E-05	1%	- -	- -	[B2]	1.1E-09	1.1E-08	7%
Benzo(g,h,i)perylene	3.1E-01	4.8E-01	9.9E-07	9.1E-06	0%	- -	- -	[D]			
Benzo(k)fluoranthene	2.3E-01	3.7E-01	7.7E-07	6.9E-06	0%	- -	- -	[B2]	4.8E-10	4.3E-09	3%
Carbazole	7.5E-02	7.5E-02				- -	- -	[B2]	4.2E-12	2.4E-11	0%
Carbon Disulfide	2.0E-03	2.0E-03	2.0E-09	1.1E-08	0%	oral and inhal.-fetus; toxicity	100	- -			
Chrysene	4.6E-01	7.8E-01	1.5E-06	1.5E-05	1%	- -	- -	[B2]	9.4E-11	9.3E-10	1%
Di-n-octyl phthalate	4.4E-02	4.4E-02	2.2E-07	1.2E-06	0%	kidney, liver; inc. weight, inc. sgot and sgpt activity	1000	- -			
Ethylbenzene	1.0E-02	1.0E-02	9.8E-09	5.7E-08	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	9.4E-01	1.7E+00	2.3E-06	2.4E-05	1%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Fluorene	9.6E-02	9.6E-02	2.3E-07	1.4E-06	0%	erythrocytes; dec. counts	3000	[D]			
Indeno(1,2,3-cd)pyrene	3.7E-01	6.1E-01	1.2E-06	1.2E-05	0%	- -	- -	[B2]	7.6E-10	7.2E-09	4%
2-Methylnaphthalene	1.5E-01	2.1E-01	4.9E-07	4.0E-06	0%	skin effects	- -	- -			
N-nitroso-di-n-propylamine	2.0E-01	2.0E-01				- -	- -	[B2]	4.0E-09	2.3E-08	14%
Phenanthrene	3.5E-01	6.4E-01	1.2E-06	1.2E-05	0%	- -	- -	[D]			
Pyrene	1.1E+00	2.0E+00	3.5E-06	3.7E-05	1%	kidney; red. weight, renal tubular pathology	3000	[D]			
Toluene	3.8E-03	3.8E-03	1.9E-09	1.1E-08	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	1000	[D]			
Xylenes	3.4E-02	8.0E-02	1.6E-09	2.3E-08	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 3.66E-04	RME 2.77E-03	100%						
Summed Cancer Risk									MLE 1.98E-08	RME 1.66E-07	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-38. RISK FROM SOIL INGESTION BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg) MLE	RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	RME	RME % of total ELCR
INORGANICS											
Antimony	1.1E-01	1.6E-01	2.6E-03	5.1E-03	1%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.8E+00	1.1E+01	2.9E-01	4.5E-01	77%	skin; keratosis, hyperpigmentation	3	[A]	1.3E-05	2.0E-05	65%
Beryllium	3.8E-01	4.5E-01	7.7E-04	1.1E-03	0%	no observed effects	100	[B2]	1.4E-06	2.1E-06	7%
Cadmium (food)	4.3E-01	6.8E-01	4.3E-03	8.7E-03	1%	kidney; proteinuria	10	- -			
Chromium (III)	3.0E+01	3.6E+01	3.0E-04	4.5E-04	0%	no observed effects	100	- -			
Copper	2.8E+01	4.5E+01	7.5E-03	1.5E-02	3%	Gastrointestinal system; irritation	- -	[D]			
Lead	2.8E+01	4.7E+01				CNS, blood	- -	[B2]			
Mercury	6.5E-02	1.2E-01	2.2E-03	5.1E-03	1%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	2.0E+01	2.3E+01	9.8E-03	1.5E-02	2%	dec. body and organ weight	300	- -			
Selenium	1.1E-01	1.8E-01	2.1E-04	4.6E-04	0%	whole body; clinical selenosis	3	[D]			
Silver	8.6E+00	1.6E+01	1.7E-02	4.2E-02	7%	skin; argyria	3	[D]			
Thallium	1.2E-01	1.9E-01	1.6E-02	3.0E-02	5%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	1.3E+02	2.3E+02	4.3E-03	9.7E-03	2%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthene	3.5E-02	3.5E-02	5.9E-06	7.5E-06	0%	liver; hepatotoxicity	3000	- -			
Anthracene	1.3E-01	1.3E-01	4.4E-06	5.5E-06	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	3.9E-01	6.8E-01	1.3E-04	2.9E-04	0%	- -	- -	[B2]	2.4E-07	5.4E-07	2%
Benzo(a)pyrene	3.8E-01	6.6E-01	1.3E-04	2.8E-04	0%	- -	- -	[B2]	2.4E-06	5.2E-06	17%
Benzo(b)fluoranthene	5.6E-01	9.6E-01	1.9E-04	4.1E-04	0%	- -	- -	[B2]	3.5E-07	7.7E-07	2%
Benzo(g,h,i)perylene	3.1E-01	4.8E-01	1.0E-04	2.1E-04	0%	- -	- -	[D]			
Benzo(k)fluoranthene	2.3E-01	3.7E-01	7.9E-05	1.6E-04	0%	- -	- -	[B2]	1.5E-07	2.9E-07	1%
Carbazole	7.5E-02	7.5E-02				- -	- -	[B2]	1.3E-09	1.6E-09	0%
Carbon Disulfide	2.0E-03	2.0E-03	2.0E-07	2.6E-07	0%	oral and inhal.-fetus; toxicity	100	- -			
Chrysene	4.6E-01	7.8E-01	1.5E-04	3.3E-04	0%	- -	- -	[B2]	2.9E-08	6.3E-08	0%
Di-n-octyl phthalate	4.4E-02	4.4E-02	2.2E-05	2.8E-05	0%	kidney, liver; inc. weight, inc. sgot and sgpt activity	1000	- -			
Ethylbenzene	1.0E-02	1.0E-02	1.0E-06	1.3E-06	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	9.4E-01	1.7E+00	2.4E-04	5.5E-04	0%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Fluorene	9.6E-02	9.6E-02	2.4E-05	3.1E-05	0%	erythrocytes; dec. counts	3000	[D]			
Indeno(1,2,3-cd)pyrene	3.7E-01	6.1E-01	1.2E-04	2.6E-04	0%	- -	- -	[B2]	2.3E-07	4.9E-07	2%
2-Methylnaphthalene	1.5E-01	2.1E-01	5.0E-05	8.9E-05	0%	skin effects	- -	- -			
N-nitroso-di-n-propylamine	2.0E-01	2.0E-01				- -	- -	[B2]	1.2E-06	1.6E-06	5%
Phenanthrene	3.5E-01	6.4E-01	1.2E-04	2.7E-04	0%	- -	- -	[D]			
Pyrene	1.1E+00	2.0E+00	3.6E-04	8.3E-04	0%	kidney; red. weight, renal tubular pathology	3000	[D]			
Toluene	3.8E-03	3.8E-03	1.9E-07	2.4E-07	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	1000	[D]			
Xylenes	3.4E-02	8.0E-02	1.7E-07	5.1E-07	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 3.60E-01	RME 5.91E-01	100%						
Summed Cancer Risk									MLE 1.93E-05	RME 3.15E-05	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-39. RISK FROM SOIL INHALATION BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	1.1E-01	1.6E-01				whole body, blood; inc. mortality	--	--			
Arsenic	8.8E+00	1.1E+01				skin; keratosis, hyperpigmentation	--	[A]	8.2E-09	1.3E-08	99%
Beryllium	3.8E-01	4.5E-01				no observed effects	--	[B2]	6.0E-11	8.8E-11	1%
Cadmium (food)	4.3E-01	6.8E-01				kidney; proteinuria	--	--	4.9E-11	9.8E-11	1%
Chromium (III)	3.0E+01	3.6E+01				no observed effects	--	--			
Copper	2.8E+01	4.5E+01				Gastrointestinal system; irritation	--	[D]			
Lead	2.8E+01	4.7E+01				CNS, blood	--	[B2]			
Mercury	6.5E-02	1.2E-01	1.6E-07	3.9E-07	100%	oral-CNS; neurotoxicity. inhal.-kidney effects	30	[D]			
Nickel	2.0E+01	2.3E+01				dec. body and organ weight	--	--			
Selenium	1.1E-01	1.8E-01				whole body; clinical selenosis	--	[D]			
Silver	8.6E+00	1.6E+01				skin; argyria	--	[D]			
Thallium	1.2E-01	1.9E-01				liver, blood; inc. sgot and serum LDH	--	[D]			
Zinc	1.3E+02	2.3E+02				blood; anemia	--	[D]			
ORGANICS											
Acenaphthene	3.5E-02	3.5E-02				liver; hepatotoxicity	--	--			
Anthracene	1.3E-01	1.3E-01				no observed effects	--	[D]			
Benzo(a)anthracene	3.9E-01	6.8E-01				--	--	[B2]			
Benzo(a)pyrene	3.8E-01	6.6E-01				--	--	[B2]			
Benzo(b)fluoranthene	5.6E-01	9.6E-01				--	--	[B2]			
Benzo(g,h,i)perylene	3.1E-01	4.8E-01				--	--	[D]			
Benzo(k)fluoranthene	2.3E-01	3.7E-01				--	--	[B2]			
Carbazole	7.5E-02	7.5E-02				--	--	[B2]			
Carbon Disulfide	2.0E-03	2.0E-03	1.5E-10	1.9E-10	0%	oral and inhal.-fetus; toxicity	1000	--			
Chrysene	4.6E-01	7.8E-01				--	--	[B2]			
Di-n-octyl phthalate	4.4E-02	4.4E-02				kidney, liver; inc. weight, inc. sgot and sgpt activity	--	--			
Ethylbenzene	1.0E-02	1.0E-02	7.6E-12	9.7E-12	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	300	[D]			
Fluoranthene	9.4E-01	1.7E+00				kidney, liver, blood; inc. weight, hematological changes	--	[D]			
Fluorene	9.6E-02	9.6E-02				erythrocytes; dec. counts	--	[D]			
Indeno(1,2,3-cd)pyrene	3.7E-01	6.1E-01				--	--	[B2]			
2-Methylnaphthalene	1.5E-01	2.1E-01				skin effects	--	--			
N-nitroso-di-n-propylamine	2.0E-01	2.0E-01				--	--	[B2]			
Phenanthrene	3.5E-01	6.4E-01				--	--	[D]			
Pyrene	1.1E+00	2.0E+00				kidney; red. weight, renal tubular pathology	--	[D]			
Toluene	3.8E-03	3.8E-03	7.2E-12	9.2E-12	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	300	[D]			
Xylenes	3.4E-02	8.0E-02				CNS hyperactivity; dec. body weight	--	[D]			
Summed Hazard Quotient			MLE 1.65E-07	RME 3.87E-07	100%						
Summed Cancer Risk									MLE 8.26E-09	RME 1.28E-08	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-40. RISK FROM SOIL DERMAL CONTACT BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg) MLE	Exposure Point Concentration in Surface Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR RME	RME % of total ELCR
INORGANICS											
Antimony	1.1E-01	1.6E-01	4.6E-06	5.1E-05	1%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.8E+00	1.1E+01	5.1E-04	4.6E-03	73%	skin; keratosis, hyperpigmentation	3	[A]	2.3E-08	2.1E-07	18%
Beryllium	3.8E-01	4.5E-01	1.3E-06	1.1E-05	0%	no observed effects	100	[B2]	2.5E-09	2.1E-08	2%
Cadmium (food)	4.3E-01	6.8E-01	7.5E-06	8.7E-05	1%	kidney; proteinuria	10	- -			
Chromium (III)	3.0E+01	3.6E+01	5.3E-07	4.6E-06	0%	no observed effects	100	- -			
Copper	2.8E+01	4.5E+01	1.3E-05	1.6E-04	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	2.8E+01	4.7E+01				CNS, blood	- -	[B2]			
Mercury	6.5E-02	1.2E-01	3.8E-06	5.1E-05	1%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	2.0E+01	2.3E+01	1.7E-05	1.5E-04	2%	dec. body and organ weight	300	- -			
Selenium	1.1E-01	1.8E-01	3.8E-07	4.6E-06	0%	whole body; clinical selenosis	3	[D]			
Silver	8.6E+00	1.6E+01	3.0E-05	4.2E-04	7%	skin; argyria	3	[D]			
Thallium	1.2E-01	1.9E-01	2.7E-05	3.0E-04	5%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	1.3E+02	2.3E+02	7.5E-06	9.7E-05	2%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthene	3.5E-02	3.5E-02	1.0E-07	7.5E-07	0%	liver; hepatotoxicity	3000	- -			
Anthracene	1.3E-01	1.3E-01	7.6E-08	5.6E-07	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	3.9E-01	6.8E-01	2.3E-06	2.9E-05	0%	- -	- -	[B2]	4.2E-09	5.4E-08	5%
Benzo(a)pyrene	3.8E-01	6.6E-01	2.3E-06	2.8E-05	0%	- -	- -	[B2]	4.2E-08	5.3E-07	47%
Benzo(b)fluoranthene	5.6E-01	9.6E-01	3.3E-06	4.1E-05	1%	- -	- -	[B2]	6.1E-09	7.7E-08	7%
Benzo(g,h,i)perylene	3.1E-01	4.8E-01	1.8E-06	2.1E-05	0%	- -	- -	[D]			
Benzo(k)fluoranthene	2.3E-01	3.7E-01	1.4E-06	1.6E-05	0%	- -	- -	[B2]	2.6E-09	2.9E-08	3%
Carbazole	7.5E-02	7.5E-02				- -	- -	[B2]	2.3E-11	1.7E-10	0%
Carbon Disulfide	2.0E-03	2.0E-03	3.5E-09	2.6E-08	0%	oral and inhal.-fetus; toxicity	100	- -			
Chrysene	4.6E-01	7.8E-01	2.7E-06	3.4E-05	1%	- -	- -	[B2]	5.1E-10	6.3E-09	1%
Di-n-octyl phthalate	4.4E-02	4.4E-02	3.9E-07	2.8E-06	0%	kidney, liver; inc. weight, inc. sgot and sgpt activity	1000	- -			
Ethylbenzene	1.0E-02	1.0E-02	1.8E-08	1.3E-07	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	9.4E-01	1.7E+00	4.1E-06	5.5E-05	1%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Fluorene	9.6E-02	9.6E-02	4.2E-07	3.1E-06	0%	erythrocytes; dec. counts	3000	[D]			
Indeno(1,2,3-cd)pyrene	3.7E-01	6.1E-01	2.2E-06	2.6E-05	0%	- -	- -	[B2]	4.1E-09	4.9E-08	4%
2-Methylnaphthalene	1.5E-01	2.1E-01	8.8E-07	9.0E-06	0%	skin effects	- -	- -			
N-nitroso-di-n-propylamine	2.0E-01	2.0E-01				- -	- -	[B2]	2.1E-08	1.6E-07	14%
Phenanthrene	3.5E-01	6.4E-01	2.1E-06	2.7E-05	0%	- -	- -	[D]			
Pyrene	1.1E+00	2.0E+00	6.2E-06	8.4E-05	1%	kidney; red. weight, renal tubular pathology	3000	[D]			
Toluene	3.8E-03	3.8E-03	3.3E-09	2.4E-08	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	1000	[D]			
Xylenes	3.4E-02	8.0E-02	3.0E-09	5.1E-08	0%	CNS hyperactivity; dec. body weight	100	[D]			

Summed Hazard Quotient	MLE	RME	
	6.58E-04	6.28E-03	100%

Summed Cancer Risk	MLE	RME	
	1.07E-07	1.13E-06	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-41. RISK FROM VAPOR INHALATION BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	1.1E-01	1.6E-01				whole body, blood; inc. mortality	--	--			
Arsenic	8.8E+00	1.1E+01				skin; keratosis, hyperpigmentation	--	[A]			
Beryllium	3.8E-01	4.5E-01				no observed effects	--	[B2]			
Cadmium (food)	4.3E-01	6.8E-01				kidney; proteinuria	--	--			
Chromium (III)	3.0E+01	3.6E+01				no observed effects	--	--			
Copper	2.8E+01	4.5E+01				Gastrointestinal system; irritation	--	[D]			
Lead	2.8E+01	4.7E+01				CNS, blood	--	[B2]			
Mercury	6.5E-02	1.2E-01				oral-CNS; neurotoxicity. inhal.-kidney effects	30	[D]			
Nickel	2.0E+01	2.3E+01				dec. body and organ weight	--	--			
Selenium	1.1E-01	1.8E-01				whole body; clinical selenosis	--	[D]			
Silver	8.6E+00	1.6E+01				skin; argyria	--	[D]			
Thallium	1.2E-01	1.9E-01				liver, blood; inc. sgot and serum LDH	--	[D]			
Zinc	1.3E+02	2.3E+02				blood; anemia	--	[D]			
ORGANICS											
Acenaphthene	3.5E-02	3.5E-02				liver; hepatotoxicity	--	--			
Anthracene	1.3E-01	1.3E-01				no observed effects	--	[D]			
Benzo(a)anthracene	3.9E-01	6.8E-01				--	--	[B2]			
Benzo(a)pyrene	3.8E-01	6.6E-01				--	--	[B2]			
Benzo(b)fluoranthene	5.6E-01	9.6E-01				--	--	[B2]			
Benzo(g,h,i)perylene	3.1E-01	4.8E-01				--	--	[D]			
Benzo(k)fluoranthene	2.3E-01	3.7E-01				--	--	[B2]			
Carbazole	7.5E-02	7.5E-02				--	--	[B2]			
Carbon Disulfide	2.0E-03	2.0E-03	1.4E-04	1.8E-04	92%	oral and inhal.-fetus; toxicity	1000	--			
Chrysene	4.6E-01	7.8E-01				--	--	[B2]			
Di-n-octyl phthalate	4.4E-02	4.4E-02				kidney, liver; inc. weight, inc. sgot and sgpt activity	--	--			
Ethylbenzene	1.0E-02	1.0E-02	6.3E-06	8.1E-06	4%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	300	[D]			
Fluoranthene	9.4E-01	1.7E+00				kidney, liver, blood; inc. weight, hematological changes	--	[D]			
Fluorene	9.6E-02	9.6E-02				erythrocytes; dec. counts	--	[D]			
Indeno(1,2,3-cd)pyrene	3.7E-01	6.1E-01				--	--	[B2]			
2-Methylnaphthalene	1.5E-01	2.1E-01				skin effects	--	--			
N-nitroso-di-n-propylamine	2.0E-01	2.0E-01				--	--	[B2]			
Phenanthrene	3.5E-01	6.4E-01				--	--	[D]			
Pyrene	1.1E+00	2.0E+00				kidney; red. weight, renal tubular pathology	--	[D]			
Toluene	3.8E-03	3.8E-03	6.0E-06	7.7E-06	4%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	300	[D]			
Xylenes	3.4E-02	8.0E-02				CNS hyperactivity; dec. body weight	--	[D]			

Summed Hazard Quotient	MLE	RME	
	1.50E-04	1.91E-04	100%

Summed Cancer Risk	MLE	RME
	--	--

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-42. RISK FROM SOIL INGESTION BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Construction Zone Soil (mg/kg)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	1.1E-01	1.6E-01	2.8E-04	5.5E-04	1%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.8E+00	1.1E+01	3.1E-02	4.9E-02	77%	skin; keratosis, hyperpigmentation	3	[A]	2.1E-06	8.8E-06	65%
Beryllium	3.8E-01	4.5E-01	8.2E-05	1.2E-04	0%	no observed effects	100	[B2]	2.3E-07	9.0E-07	7%
Cadmium (food)	4.3E-01	6.8E-01	4.6E-04	9.3E-04	1%	kidney; proteinuria	10	- -			
Chromium (III)	3.0E+01	3.6E+01	3.2E-05	4.9E-05	0%	no observed effects	100	- -			
Copper	2.8E+01	4.5E+01	8.0E-04	1.7E-03	3%	Gastrointestinal system; irritation	- -	[D]			
Lead	2.8E+01	4.7E+01				CNS, blood	- -	[B2]			
Mercury	6.5E-02	1.2E-01	2.3E-04	5.5E-04	1%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	2.0E+01	2.3E+01	1.0E-03	1.6E-03	2%	dec. body and organ weight	300	- -			
Selenium	1.1E-01	1.8E-01	2.3E-05	4.9E-05	0%	whole body; clinical selenosis	3	[D]			
Silver	8.6E+00	1.6E+01	1.9E-03	4.5E-03	7%	skin; argyria	3	[D]			
Thallium	1.2E-01	1.9E-01	1.7E-03	3.2E-03	5%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	1.3E+02	2.3E+02	4.6E-04	1.0E-03	2%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthene	3.5E-02	3.5E-02	6.3E-07	8.0E-07	0%	liver; hepatotoxicity	3000	- -			
Anthracene	1.3E-01	1.3E-01	4.7E-07	5.9E-07	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	3.9E-01	6.8E-01	1.4E-05	3.1E-05	0%	- -	- -	[B2]	3.9E-08	2.3E-07	2%
Benzo(a)pyrene	3.8E-01	6.6E-01	1.4E-05	3.0E-05	0%	- -	- -	[B2]	3.9E-07	2.2E-06	17%
Benzo(b)fluoranthene	5.6E-01	9.6E-01	2.0E-05	4.4E-05	0%	- -	- -	[B2]	5.6E-08	3.3E-07	2%
Benzo(g,h,i)perylene	3.1E-01	4.8E-01	1.1E-05	2.2E-05	0%	- -	- -	[D]			
Benzo(k)fluoranthene	2.3E-01	3.7E-01	8.4E-06	1.7E-05	0%	- -	- -	[B2]	2.4E-08	1.3E-07	1%
Carbazole	7.5E-02	7.5E-02				- -	- -	[B2]	2.1E-10	7.0E-10	0%
Carbon Disulfide	2.0E-03	2.0E-03	2.2E-08	2.7E-08	0%	oral and inhal.-fetus; toxicity	100	- -			
Chrysene	4.6E-01	7.8E-01	1.7E-05	3.6E-05	0%	- -	- -	[B2]	4.6E-09	2.7E-08	0%
Di-n-octyl phthalate	4.4E-02	4.4E-02	2.4E-06	3.0E-06	0%	kidney, liver; inc. weight, inc. sgot and sgpt activity	1000	- -			
Ethylbenzene	1.0E-02	1.0E-02	1.1E-07	1.4E-07	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	9.4E-01	1.7E+00	2.5E-05	5.9E-05	0%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Fluorene	9.6E-02	9.6E-02	2.6E-06	3.3E-06	0%	erythrocytes; dec. counts	3000	[D]			
Indeno(1,2,3-cd)pyrene	3.7E-01	6.1E-01	1.3E-05	2.8E-05	0%	- -	- -	[B2]	3.7E-08	2.1E-07	2%
2-Methylnaphthalene	1.5E-01	2.1E-01	5.4E-06	9.6E-06	0%	skin effects	- -	- -			
N-nitroso-di-n-propylamine	2.0E-01	2.0E-01				- -	- -	[B2]	2.0E-07	6.7E-07	5%
Phenanthrene	3.5E-01	6.4E-01	1.3E-05	2.9E-05	0%	- -	- -	[D]			
Pyrene	1.1E+00	2.0E+00	3.8E-05	8.9E-05	0%	kidney; red. weight, renal tubular pathology	3000	[D]			
Toluene	3.8E-03	3.8E-03	2.0E-08	2.6E-08	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	1000	[D]			
Xylenes	3.4E-02	8.0E-02	1.8E-08	5.5E-08	0%	CNS hyperactivity; dec. body weight	100	[D]			

Summed Hazard Quotient	MLE	RME	
	3.86E-02	6.33E-02	100%

Summed Cancer Risk	MLE	RME	
	3.10E-06	1.35E-05	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-43. RISK FROM SOIL INHALATION BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg) MLE	Exposure Point Concentration in Surface Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR RME	RME % of total ELCR
INORGANICS											
Antimony	1.1E-01	1.6E-01				whole body, blood; inc. mortality	--	--			
Arsenic	8.8E+00	1.1E+01				skin; keratosis, hyperpigmentation	--	[A]	2.6E-09	1.4E-08	99%
Beryllium	3.8E-01	4.5E-01				no observed effects	--	[B2]	1.9E-11	9.5E-11	1%
Cadmium (food)	4.3E-01	6.8E-01				kidney; proteinuria	--	--	1.6E-11	1.1E-10	1%
Chromium (III)	3.0E+01	3.6E+01				no observed effects	--	--			
Copper	2.8E+01	4.5E+01				Gastrointestinal system; irritation	--	[D]			
Lead	2.8E+01	4.7E+01				CNS, blood	--	[B2]			
Mercury	6.5E-02	1.2E-01	3.5E-08	8.3E-08	100%	oral-CNS; neurotoxicity. inhal.-kidney effects	30	[D]			
Nickel	2.0E+01	2.3E+01				dec. body and organ weight	--	--			
Selenium	1.1E-01	1.8E-01				whole body; clinical selenosis	--	[D]			
Silver	8.6E+00	1.6E+01				skin; argyria	--	[D]			
Thallium	1.2E-01	1.9E-01				liver, blood; inc. sgot and serum LDH	--	[D]			
Zinc	1.3E+02	2.3E+02				blood; anemia	--	[D]			
ORGANICS											
Acenaphthene	3.5E-02	3.5E-02				liver; hepatotoxicity	--	--			
Anthracene	1.3E-01	1.3E-01				no observed effects	--	[D]			
Benzo(a)anthracene	3.9E-01	6.8E-01				--	--	[B2]			
Benzo(a)pyrene	3.8E-01	6.6E-01				--	--	[B2]			
Benzo(b)fluoranthene	5.6E-01	9.6E-01				--	--	[B2]			
Benzo(g,h,i)perylene	3.1E-01	4.8E-01				--	--	[D]			
Benzo(k)fluoranthene	2.3E-01	3.7E-01				--	--	[B2]			
Carbazole	7.5E-02	7.5E-02				--	--	[B2]			
Carbon Disulfide	2.0E-03	2.0E-03	3.3E-11	4.1E-11	0%	oral and inhal.-fetus; toxicity	1000	--			
Chrysene	4.6E-01	7.8E-01				--	--	[B2]			
Di-n-octyl phthalate	4.4E-02	4.4E-02				kidney, liver; inc. weight, inc. sgot and sgpt activity	--	--			
Ethylbenzene	1.0E-02	1.0E-02	1.6E-12	2.1E-12	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	300	[D]			
Fluoranthene	9.4E-01	1.7E+00				kidney, liver, blood; inc. weight, hematological changes	--	[D]			
Fluorene	9.6E-02	9.6E-02				erythrocytes; dec. counts	--	[D]			
Indeno(1,2,3-cd)pyrene	3.7E-01	6.1E-01				--	--	[B2]			
2-Methylnaphthalene	1.5E-01	2.1E-01				skin effects	--	--			
N-nitroso-di-n-propylamine	2.0E-01	2.0E-01				--	--	[B2]			
Phenanthrene	3.5E-01	6.4E-01				--	--	[D]			
Pyrene	1.1E+00	2.0E+00				kidney; red. weight, renal tubular pathology	--	[D]			
Toluene	3.8E-03	3.8E-03	1.5E-12	2.0E-12	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	300	[D]			
Xylenes	3.4E-02	8.0E-02				CNS hyperactivity; dec. body weight	--	[D]			
Summed Hazard Quotient			MLE 3.53E-08	RME 8.29E-08	100%						
Summed Cancer Risk									MLE 2.66E-09	RME 1.37E-08	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-44. RISK FROM SOIL DERMAL CONTACT BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	1.1E-01	1.6E-01	2.8E-06	3.2E-05	1%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.8E+00	1.1E+01	3.1E-04	2.8E-03	73%	skin; keratosis, hyperpigmentation	3	[A]	2.1E-08	6.4E-07	18%
Beryllium	3.8E-01	4.5E-01	8.2E-07	7.1E-06	0%	no observed effects	100	[B2]	2.3E-09	6.5E-08	2%
Cadmium (food)	4.3E-01	6.8E-01	4.6E-06	5.4E-05	1%	kidney; proteinuria	10	- -			
Chromium (III)	3.0E+01	3.6E+01	3.2E-07	2.8E-06	0%	no observed effects	100	- -			
Copper	2.8E+01	4.5E+01	8.0E-06	9.6E-05	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	2.8E+01	4.7E+01				CNS, blood	- -	[B2]			
Mercury	6.5E-02	1.2E-01	2.3E-06	3.2E-05	1%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	2.0E+01	2.3E+01	1.0E-05	9.1E-05	2%	dec. body and organ weight	300	- -			
Selenium	1.1E-01	1.8E-01	2.3E-07	2.9E-06	0%	whole body; clinical selenosis	3	[D]			
Silver	8.6E+00	1.6E+01	1.9E-05	2.6E-04	7%	skin; argyria	3	[D]			
Thallium	1.2E-01	1.9E-01	1.7E-05	1.9E-04	5%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	1.3E+02	2.3E+02	4.6E-06	6.0E-05	2%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthene	3.5E-02	3.5E-02	6.3E-08	4.6E-07	0%	liver; hepatotoxicity	3000	- -			
Anthracene	1.3E-01	1.3E-01	4.7E-08	3.4E-07	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	3.9E-01	6.8E-01	1.4E-06	1.8E-05	0%	- -	- -	[B2]	3.9E-09	1.7E-07	5%
Benzo(a)pyrene	3.8E-01	6.6E-01	1.4E-06	1.7E-05	0%	- -	- -	[B2]	3.9E-08	1.6E-06	47%
Benzo(b)fluoranthene	5.6E-01	9.6E-01	2.0E-06	2.5E-05	1%	- -	- -	[B2]	5.6E-09	2.4E-07	7%
Benzo(g,h,i)perylene	3.1E-01	4.8E-01	1.1E-06	1.3E-05	0%	- -	- -	[D]			
Benzo(k)fluoranthene	2.3E-01	3.7E-01	8.4E-07	9.7E-06	0%	- -	- -	[B2]	2.4E-09	9.1E-08	3%
Carbazole	7.5E-02	7.5E-02				- -	- -	[B2]	2.1E-11	5.1E-10	0%
Carbon Disulfide	2.0E-03	2.0E-03	2.2E-09	1.6E-08	0%	oral and inhal.-fetus; toxicity	100	- -			
Chrysene	4.6E-01	7.8E-01	1.7E-06	2.1E-05	1%	- -	- -	[B2]	4.6E-10	1.9E-08	1%
Di-n-octyl phthalate	4.4E-02	4.4E-02	2.4E-07	1.7E-06	0%	kidney, liver; inc. weight, inc. sgot and sgpt activity	1000	- -			
Ethylbenzene	1.0E-02	1.0E-02	1.1E-08	7.9E-08	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	9.4E-01	1.7E+00	2.5E-06	3.4E-05	1%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Fluorene	9.6E-02	9.6E-02	2.6E-07	1.9E-06	0%	erythrocytes; dec. counts	3000	[D]			
Indeno(1,2,3-cd)pyrene	3.7E-01	6.1E-01	1.3E-06	1.6E-05	0%	- -	- -	[B2]	3.7E-09	1.5E-07	4%
2-Methylnaphthalene	1.5E-01	2.1E-01	5.4E-07	5.6E-06	0%	skin effects	- -	- -			
N-nitroso-di-n-propylamine	2.0E-01	2.0E-01				- -	- -	[B2]	2.0E-08	4.8E-07	14%
Phenanthrene	3.5E-01	6.4E-01	1.3E-06	1.7E-05	0%	- -	- -	[D]			
Pyrene	1.1E+00	2.0E+00	3.8E-06	5.2E-05	1%	kidney; red. weight, renal tubular pathology	3000	[D]			
Toluene	3.8E-03	3.8E-03	2.0E-09	1.5E-08	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	1000	[D]			
Xylenes	3.4E-02	8.0E-02	1.8E-09	3.2E-08	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 4.03E-04	RME 3.88E-03	100%						
Summed Cancer Risk									MLE 9.80E-08	RME 3.48E-06	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-45. RISK FROM VAPOR INHALATION BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg) MLE	RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	RME	RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	RME	RME % of total ELCR
INORGANICS											
Antimony	1.1E-01	1.6E-01				whole body, blood; inc. mortality	--	--			
Arsenic	8.8E+00	1.1E+01				skin; keratosis, hyperpigmentation	--	[A]			
Beryllium	3.8E-01	4.5E-01				no observed effects	--	[B2]			
Cadmium (food)	4.3E-01	6.8E-01				kidney; proteinuria	--	--			
Chromium (III)	3.0E+01	3.6E+01				no observed effects	--	--			
Copper	2.8E+01	4.5E+01				Gastrointestinal system; irritation	--	[D]			
Lead	2.8E+01	4.7E+01				CNS, blood	--	[B2]			
Mercury	6.5E-02	1.2E-01				oral-CNS; neurotoxicity. inhal.-kidney effects	30	[D]			
Nickel	2.0E+01	2.3E+01				dec. body and organ weight	--	--			
Selenium	1.1E-01	1.8E-01				whole body; clinical selenosis	--	[D]			
Silver	8.6E+00	1.6E+01				skin; argyria	--	[D]			
Thallium	1.2E-01	1.9E-01				liver, blood; inc. sgot and serum LDH	--	[D]			
Zinc	1.3E+02	2.3E+02				blood; anemia	--	[D]			
ORGANICS											
Acenaphthene	3.5E-02	3.5E-02				liver; hepatotoxicity	--	--			
Anthracene	1.3E-01	1.3E-01				no observed effects	--	[D]			
Benzo(a)anthracene	3.9E-01	6.8E-01				--	--	[B2]			
Benzo(a)pyrene	3.8E-01	6.6E-01				--	--	[B2]			
Benzo(b)fluoranthene	5.6E-01	9.6E-01				--	--	[B2]			
Benzo(g,h,i)perylene	3.1E-01	4.8E-01				--	--	[D]			
Benzo(k)fluoranthene	2.3E-01	3.7E-01				--	--	[B2]			
Carbazole	7.5E-02	7.5E-02				--	--	[B2]			
Carbon Disulfide	2.0E-03	2.0E-03	3.0E-05	3.8E-05	92%	oral and inhal.-fetus; toxicity	1000	--			
Chrysene	4.6E-01	7.8E-01				--	--	[B2]			
Di-n-octyl phthalate	4.4E-02	4.4E-02				kidney, liver; inc. weight, inc. sgot and sgpt activity	--	--			
Ethylbenzene	1.0E-02	1.0E-02	1.4E-06	1.7E-06	4%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	300	[D]			
Fluoranthene	9.4E-01	1.7E+00				kidney, liver, blood; inc. weight, hematological changes	--	[D]			
Fluorene	9.6E-02	9.6E-02				erythrocytes; dec. counts	--	[D]			
Indeno(1,2,3-cd)pyrene	3.7E-01	6.1E-01				--	--	[B2]			
2-Methylnaphthalene	1.5E-01	2.1E-01				skin effects	--	--			
N-nitroso-di-n-propylamine	2.0E-01	2.0E-01				--	--	[B2]			
Phenanthrene	3.5E-01	6.4E-01				--	--	[D]			
Pyrene	1.1E+00	2.0E+00				kidney; red. weight, renal tubular pathology	--	[D]			
Toluene	3.8E-03	3.8E-03	1.3E-06	1.6E-06	4%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	300	[D]			
Xylenes	3.4E-02	8.0E-02				CNS hyperactivity; dec. body weight	--	[D]			
Summed Hazard Quotient			MLE 3.22E-05	RME 4.10E-05	100%						
Summed Cancer Risk									MLE --	RME --	

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-46. RISK FROM GROUNDWATER INGESTION BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l) MLE	RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	RME	RME % of total ELCR
INORGANICS											
Antimony	1.6E-03	1.9E-03	2.0E-01	3.0E-01	3%	whole body, blood; inc. mortality	1000	- -			
Arsenic	2.5E-02	4.7E-02	4.1E+00	1.0E+01	86%	skin; keratosis, hyperpigmentation	3	[A]	1.8E-04	4.5E-04	88%
Beryllium	2.5E-03	2.6E-03	2.5E-02	3.3E-02	0%	no observed effects	100	[B2]	4.6E-05	6.1E-05	12%
Cadmium (water)	2.4E-03	3.8E-03	2.4E-01	4.9E-01	4%	kidney; proteinuria	10	- -			
Chromium (III)	7.6E-02	8.4E-02	3.8E-03	5.4E-03	0%	no observed effects	100	- -			
Copper	1.2E-01	1.2E-01	1.6E-01	2.1E-01	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	5.4E-02	6.2E-02				CNS, blood	- -	[B2]			
Nickel	1.3E-01	1.3E-01	3.2E-01	4.1E-01	4%	dec. body and organ weight	300	- -			
Silver	6.1E-03	1.1E-02	6.1E-02	1.4E-01	1%	skin; argyria	3	[D]			
Zinc	3.2E-01	4.3E-01	5.4E-02	9.1E-02	1%	blood; anemia	3	[D]			
Summed Hazard Quotient			MLE 5.17E+00	RME 1.16E+01	100%						
Summed Cancer Risk									MLE 2.31E-04	RME 5.09E-04	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-47. RISK FROM GROUNDWATER INHALATION BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		Noncarcinogenic Effects: RME % of total HQ	Noncarcinogenic Effects: Target Organ System	Noncarcinogenic Effects: UF (inhalation)	Carcinogenic Effects: WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		Carcinogenic Effects: RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	1.6E-03	1.9E-03				whole body, blood; inc. mortality	- -	- -			
Arsenic	2.5E-02	4.7E-02				skin; keratosis, hyperpigmentation	- -	[A]			
Beryllium	2.5E-03	2.6E-03				no observed effects	- -	[B2]			
Cadmium (water)	2.4E-03	3.8E-03				kidney; proteinuria	- -	- -			
Chromium (III)	7.6E-02	8.4E-02				no observed effects	- -	- -			
Copper	1.2E-01	1.2E-01				Gastrointestinal system; irritation	- -	[D]			
Lead	5.4E-02	6.2E-02				CNS, blood	- -	[B2]			
Nickel	1.3E-01	1.3E-01				dec. body and organ weight	- -	- -			
Silver	6.1E-03	1.1E-02				skin; argyria	- -	[D]			
Zinc	3.2E-01	4.3E-01				blood; anemia	- -	[D]			

Summed Hazard Quotient	MLE	RME
	--	--

Summed Cancer Risk	MLE	RME
	--	--

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-48. RISK FROM GROUNDWATER DERMAL CONTACT BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l) MLE	Exposure Point Concentration in Groundwater (mg/l) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	1.6E-03	1.9E-03	1.6E-04	4.0E-04	3%	whole body, blood; inc. mortality	1000	- -			
Arsenic	2.5E-02	4.7E-02	3.3E-03	1.3E-02	89%	skin; keratosis, hyperpigmentation	3	[A]	4.9E-08	1.9E-07	98%
Beryllium	2.5E-03	2.6E-03	2.1E-05	4.4E-05	0%	no observed effects	100	[B2]	2.0E-09	4.4E-09	2%
Cadmium (water)	2.4E-03	3.8E-03	2.0E-04	6.5E-04	4%	kidney; proteinuria	10	- -			
Chromium (III)	7.6E-02	8.4E-02	6.3E-06	1.4E-05	0%	no observed effects	100	- -			
Copper	1.2E-01	1.2E-01	1.3E-04	2.9E-04	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	5.4E-02	6.2E-02				CNS, blood	- -	[B2]			
Nickel	1.3E-01	1.3E-01	2.6E-05	5.5E-05	0%	dec. body and organ weight	300	- -			
Silver	6.1E-03	1.1E-02	5.0E-05	1.8E-04	1%	skin; argyria	3	[D]			
Zinc	3.2E-01	4.3E-01	2.6E-05	7.3E-05	0%	blood; anemia	3	[D]			

Summed Hazard Quotient	MLE	RME	
	3.97E-03	1.50E-02	100%

Summed Cancer Risk	MLE	RME	
	5.13E-08	1.99E-07	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-49. RISK FROM GROUNDWATER INGESTION BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l) MLE	Exposure Point Concentration in Groundwater (mg/l) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	1.6E-03	1.9E-03	6.0E-02	1.3E-01	3%	whole body, blood; inc. mortality	1000	- -			
Arsenic	2.5E-02	4.7E-02	1.2E+00	4.3E+00	86%	skin; keratosis, hyperpigmentation	3	[A]	8.3E-05	9.6E-04	88%
Beryllium	2.5E-03	2.6E-03	7.5E-03	1.4E-02	0%	no observed effects	100	[B2]	2.1E-05	1.3E-04	12%
Cadmium (water)	2.4E-03	3.8E-03	7.2E-02	2.1E-01	4%	kidney; proteinuria	10	- -			
Chromium (III)	7.6E-02	8.4E-02	1.1E-03	2.3E-03	0%	no observed effects	100	- -			
Copper	1.2E-01	1.2E-01	4.8E-02	9.2E-02	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	5.4E-02	6.2E-02				CNS, blood	- -	[B2]			
Nickel	1.3E-01	1.3E-01	9.6E-02	1.8E-01	4%	dec. body and organ weight	300	- -			
Silver	6.1E-03	1.1E-02	1.8E-02	5.9E-02	1%	skin; argyria	3	[D]			
Zinc	3.2E-01	4.3E-01	1.6E-02	3.9E-02	1%	blood; anemia	3	[D]			
Summed Hazard Quotient			MLE 1.55E+00	RME 4.99E+00	100%						
Summed Cancer Risk									MLE 1.04E-04	RME 1.09E-03	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-50. RISK FROM GROUNDWATER INHALATION BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l) MLE	Exposure Point Concentration in Groundwater (mg/l) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	1.6E-03	1.9E-03				whole body, blood; inc. mortality	--	--			
Arsenic	2.5E-02	4.7E-02				skin; keratosis, hyperpigmentation	--	[A]			
Beryllium	2.5E-03	2.6E-03				no observed effects	--	[B2]			
Cadmium (water)	2.4E-03	3.8E-03				kidney; proteinuria	--	--			
Chromium (III)	7.6E-02	8.4E-02				no observed effects	--	--			
Copper	1.2E-01	1.2E-01				Gastrointestinal system; irritation	--	[D]			
Lead	5.4E-02	6.2E-02				CNS, blood	--	[B2]			
Nickel	1.3E-01	1.3E-01				dec. body and organ weight	--	--			
Silver	6.1E-03	1.1E-02				skin; argyria	--	[D]			
Zinc	3.2E-01	4.3E-01				blood; anemia	--	[D]			

Summed Hazard Quotient	MLE	RME
	--	--

Summed Cancer Risk	MLE	RME
	--	--

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-51. RISK FROM GROUNDWATER DERMAL CONTACT BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 3 - LEACH FIELD, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	1.6E-03	1.9E-03	1.0E-04	2.2E-04	3%	whole body, blood; inc. mortality	1000	- -			
Arsenic	2.5E-02	4.7E-02	2.1E-03	7.1E-03	89%	skin; keratosis, hyperpigmentation	3	[A]	4.5E-08	5.2E-07	98%
Beryllium	2.5E-03	2.6E-03	1.3E-05	2.4E-05	0%	no observed effects	100	[B2]	1.9E-09	1.2E-08	2%
Cadmium (water)	2.4E-03	3.8E-03	1.2E-04	3.5E-04	4%	kidney; proteinuria	10	- -			
Chromium (III)	7.6E-02	8.4E-02	3.8E-06	7.7E-06	0%	no observed effects	100	- -			
Copper	1.2E-01	1.2E-01	8.0E-05	1.5E-04	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	5.4E-02	6.2E-02				CNS, blood	- -	[B2]			
Nickel	1.3E-01	1.3E-01	1.6E-05	2.9E-05	0%	dec. body and organ weight	300	- -			
Silver	6.1E-03	1.1E-02	3.1E-05	9.9E-05	1%	skin; argyria	3	[D]			
Zinc	3.2E-01	4.3E-01	1.6E-05	3.9E-05	0%	blood; anemia	3	[D]			
Summed Hazard Quotient			MLE 2.43E-03	RME 8.02E-03	100%						
Summed Cancer Risk									MLE 4.71E-08	RME 5.34E-07	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

Table H-52. Risk Estimate Summary - RME Risks
Site 5 - Ramp Drainage Ditch
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

CURRENT - OCCUPATIONAL

MEDIA	ROUTE	BASE PERSONNEL				CONSTRUCTION WORKER			
		Noncancer		Cancer		Noncancer		Cancer	
Soil	Ingestion	2.3E-02	B	2.2E-05	W	2.9E-01	B	2.1E-05	W
	Dermal	2.2E-03	B	1.2E-05	W	5.7E-03	B	2.3E-06	W
Soil Total	**Combined**	**2.6E-02**	B	**3.4E-05**	W	**3.0E-01**	B	**2.4E-05**	W

TOTAL	**2.6E-02**	B	**3.4E-05**	W	**3.0E-01**	B	**2.4E-05**	W

FUTURE - RESIDENTIAL

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Soil	Ingestion	8.0E-01	B	1.8E-04	E	8.5E-02	B	7.5E-05	W
	Inhalation	2.9E-07	B	1.3E-08	B	6.2E-08	B	1.4E-08	B
	Dermal	1.3E-02	B	1.6E-05	W	8.0E-03	B	4.9E-05	W
Soil Total	**Combined**	**8.1E-01**	B	**1.9E-04**	E	**9.3E-02**	B	**1.2E-04**	E

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Air (vapors) Total	**Inhalation**	--	--	--	--	--	--	--	--

TOTAL	**8.1E-01**	B	**1.9E-04**	E	**9.3E-02**	B	**1.2E-04**	E

"B" - Below EPA human noncancer health effects target (HI < 1) or cancer risk (ELCR < 1 x 10-6)
"W" - Within EPA target cancer risk range (ELCR <= 1 x 10-4 and >= 1 x 10-6)
"E" - Exceeds EPA human noncancer health effects target (HI > 1) or cancer risks (ELCR > 1 x 10E-4)
-- No results are available for this route because detected chemicals do not easily volatilize and/or have no EPA-approved toxicity values

TABLE H-53. RISK FROM SOIL INGESTION BY BASE PERSONNEL - CURRENT CONDITIONS
SITE 5 - RAMP DRAINAGE DITCH, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg) MLE	RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	RME	RME % of total ELCR
INORGANICS											
Antimony	5.1E-01	6.6E-01	1.2E-04	6.4E-04	3%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.4E+00	9.3E+00	2.7E-03	1.2E-02	52%	skin; keratosis, hyperpigmentation	3	[A]	5.1E-07	2.3E-06	10%
Beryllium	4.5E-01	5.0E-01	8.7E-06	3.9E-05	0%	no observed effects	100	[B2]	6.7E-08	3.0E-07	1%
Cadmium (food)	7.8E+00	1.6E+01	7.6E-04	6.1E-03	26%	kidney; proteinuria	10	- -			
Chromium (III)	6.6E+01	1.2E+02	6.5E-06	4.6E-05	0%	no observed effects	100	- -			
Copper	2.9E+01	4.2E+01	7.7E-05	4.5E-04	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	1.3E+02	2.4E+02				CNS, blood	- -	[B2]			
Mercury	5.5E-02	9.0E-02	1.8E-05	1.2E-04	1%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	1.8E+01	2.2E+01	8.6E-05	4.3E-04	2%	dec. body and organ weight	300	- -			
Thallium	2.1E-01	2.4E-01	2.5E-04	1.2E-03	5%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	2.5E+02	4.7E+02	8.2E-05	6.1E-04	3%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthene	2.3E-01	3.4E-01	3.8E-07	2.2E-06	0%	liver; hepatotoxicity	3000	- -			
Anthracene	5.1E-01	1.0E+00	1.7E-07	1.4E-06	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	4.2E+00	1.1E+01	1.4E-05	1.4E-04	1%	- -	- -	[B2]	1.1E-07	1.1E-06	5%
Benzo(a)pyrene	4.6E+00	1.1E+01	1.5E-05	1.5E-04	1%	- -	- -	[B2]	1.2E-06	1.2E-05	52%
Benzo(b)fluoranthene	7.5E+00	1.9E+01	2.5E-05	2.5E-04	1%	- -	- -	[B2]	1.9E-07	1.9E-06	9%
Benzo(g,h,i)perylene	4.2E+00	9.5E+00	1.4E-05	1.2E-04	1%	- -	- -	[D]			
Benzo(k)fluoranthene	2.6E+00	6.6E+00	8.6E-06	8.6E-05	0%	- -	- -	[B2]	6.7E-08	6.8E-07	3%
Carbazole	3.7E-01	8.2E-01				- -	- -	[B2]	2.6E-10	2.3E-09	0%
Chrysene	4.5E+00	1.1E+01	1.5E-05	1.4E-04	1%	- -	- -	[B2]	1.2E-08	1.1E-07	0%
Dibenzo(a,h)anthracene	1.2E+00	3.0E+00	3.9E-06	3.9E-05	0%	- -	- -	[B2]	3.0E-07	3.0E-06	14%
Dibenzofuran	1.7E-01	2.1E-01				- -	- -	[D]			
Di-n-octyl phthalate	1.4E-01	1.4E-01	6.9E-07	2.8E-06	0%	kidney, liver; inc. weight, inc. sgot and sgpt activity	1000	- -			
Fluoranthene	7.7E+00	1.7E+01	1.9E-05	1.7E-04	1%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Fluorene	2.5E-01	3.6E-01	6.1E-07	3.5E-06	0%	erythrocytes; dec. counts	3000	[D]			
Indeno(1,2,3-cd)pyrene	5.1E+00	1.2E+01	1.7E-05	1.6E-04	1%	- -	- -	[B2]	1.3E-07	1.3E-06	6%
2-Methylnaphthalene	7.4E-01	1.8E+00	2.4E-06	2.4E-05	0%	skin effects	- -	- -			
Naphthalene	2.7E-01	3.7E-01				dec. body weight	- -	[D]			
Phenanthrene	3.1E+00	6.4E+00	1.0E-05	8.4E-05	0%	- -	- -	[D]			
Pyrene	9.3E+00	2.1E+01	3.0E-05	2.8E-04	1%	kidney; red. weight, renal tubular pathology	3000	[D]			

	MLE	RME	
Summed Hazard Quotient	4.31E-03	2.34E-02	100%

	MLE	RME	
Summed Cancer Risk	2.57E-06	2.24E-05	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-54. RISK FROM SOIL DERMAL CONTACT BY BASE PERSONNEL - CURRENT CONDITIONS
SITE 5 - RAMP DRAINAGE DITCH, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg) MLE	RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	RME	RME % of total ELCR
INORGANICS											
Antimony	5.1E-01	6.6E-01	2.5E-06	3.7E-05	2%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.4E+00	9.3E+00	5.4E-05	7.0E-04	32%	skin; keratosis, hyperpigmentation	3	[A]	1.0E-08	1.3E-07	1%
Beryllium	4.5E-01	5.0E-01	1.7E-07	2.3E-06	0%	no observed effects	100	[B2]	1.3E-09	1.7E-08	0%
Cadmium (food)	7.8E+00	1.6E+01	1.5E-05	3.5E-04	16%	kidney; proteinuria	10	- -			
Chromium (III)	6.6E+01	1.2E+02	1.3E-07	2.7E-06	0%	no observed effects	100	- -			
Copper	2.9E+01	4.2E+01	1.5E-06	2.6E-05	1%	Gastrointestinal system; irritation	- -	[D]			
Lead	1.3E+02	2.4E+02				CNS, blood	- -	[B2]			
Mercury	5.5E-02	9.0E-02	3.6E-07	6.8E-06	0%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	1.8E+01	2.2E+01	1.7E-06	2.5E-05	1%	dec. body and organ weight	300	- -			
Thallium	2.1E-01	2.4E-01	5.0E-06	6.8E-05	3%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	2.5E+02	4.7E+02	1.6E-06	3.5E-05	2%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthene	2.3E-01	3.4E-01	7.5E-08	1.3E-06	0%	liver; hepatotoxicity	3000	- -			
Anthracene	5.1E-01	1.0E+00	3.3E-08	7.9E-07	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	4.2E+00	1.1E+01	2.7E-06	8.1E-05	4%	- -	- -	[B2]	2.1E-08	6.3E-07	5%
Benzo(a)pyrene	4.6E+00	1.1E+01	3.0E-06	8.7E-05	4%	- -	- -	[B2]	2.4E-07	6.8E-06	58%
Benzo(b)fluoranthene	7.5E+00	1.9E+01	4.9E-06	1.4E-04	6%	- -	- -	[B2]	3.8E-08	1.1E-06	10%
Benzo(g,h,i)perylene	4.2E+00	9.5E+00	2.8E-06	7.2E-05	3%	- -	- -	[D]			
Benzo(k)fluoranthene	2.6E+00	6.6E+00	1.7E-06	5.0E-05	2%	- -	- -	[B2]	1.3E-08	3.9E-07	3%
Carbazole	3.7E-01	8.2E-01				- -	- -	[B2]	5.1E-11	1.3E-09	0%
Chrysene	4.5E+00	1.1E+01	3.0E-06	8.3E-05	4%	- -	- -	[B2]	2.3E-09	6.5E-08	1%
Dibenzo(a,h)anthracene	1.2E+00	3.0E+00	7.8E-07	2.3E-05	1%	- -	- -	[B2]	6.1E-08	1.8E-06	15%
Dibenzofuran	1.7E-01	2.1E-01				- -	- -	[D]			
Di-n-octyl phthalate	1.4E-01	1.4E-01	1.4E-07	1.6E-06	0%	kidney, liver; inc. weight, inc. sgot and sgpt activity	1000	- -			
Fluoranthene	7.7E+00	1.7E+01	3.8E-06	9.8E-05	4%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Fluorene	2.5E-01	3.6E-01	1.2E-07	2.0E-06	0%	erythrocytes; dec. counts	3000	[D]			
Indeno(1,2,3-cd)pyrene	5.1E+00	1.2E+01	3.3E-06	9.3E-05	4%	- -	- -	[B2]	2.6E-08	7.3E-07	6%
2-Methylnaphthalene	7.4E-01	1.8E+00	4.8E-07	1.4E-05	1%	skin effects	- -	- -			
Naphthalene	2.7E-01	3.7E-01				dec. body weight	- -	[D]			
Phenanthrene	3.1E+00	6.4E+00	2.0E-06	4.9E-05	2%	- -	- -	[D]			
Pyrene	9.3E+00	2.1E+01	6.1E-06	1.6E-04	7%	kidney; red. weight, renal tubular pathology	3000	[D]			
Summed Hazard Quotient			MLE 1.18E-04	RME 2.22E-03	100%						
Summed Cancer Risk									MLE 4.10E-07	RME 1.16E-05	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-55. RISK FROM SOIL INGESTION BY CONSTRUCTION WORKER - CURRENT CONDITIONS
SITE 5 - RAMP DRAINAGE DITCH, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Construction Zone Soil (mg/kg) MLE	RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	RME	RME % of total ELCR
INORGANICS											
Antimony	5.1E-01	6.6E-01	2.5E-03	7.7E-03	3%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.4E+00	9.3E+00	5.4E-02	1.5E-01	50%	skin; keratosis, hyperpigmentation	3	[A]	8.2E-07	2.2E-06	10%
Beryllium	4.5E-01	5.0E-01	1.7E-04	4.7E-04	0%	no observed effects	100	[B2]	1.1E-07	2.9E-07	1%
Cadmium (food)	7.8E+00	1.6E+01	1.5E-02	7.3E-02	25%	kidney; proteinuria	10	- -			
Chromium (III)	6.6E+01	1.2E+02	1.3E-04	5.5E-04	0%	no observed effects	100	- -			
Copper	2.9E+01	4.2E+01	1.5E-03	5.3E-03	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	1.3E+02	2.4E+02				CNS, blood	- -	[B2]			
Mercury	5.5E-02	9.0E-02	3.6E-04	1.4E-03	0%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	1.8E+01	2.2E+01	1.7E-03	5.1E-03	2%	dec. body and organ weight	300	- -			
Silver	1.3E+00	1.6E+00	5.0E-04	1.5E-03	1%	skin; argyria	3	[D]			
Thallium	3.2E-01	4.2E-01	7.7E-03	2.5E-02	8%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	2.5E+02	4.7E+02	1.6E-03	7.3E-03	3%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthene	2.3E-01	3.4E-01	7.5E-06	2.7E-05	0%	liver; hepatotoxicity	3000	- -			
Acetone	1.1E-02	1.6E-02	2.2E-07	7.5E-07	0%	inc. liver, kidney weights, nephrotoxicity	1000	[D]			
Anthracene	5.1E-01	1.0E+00	3.3E-06	1.6E-05	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	4.2E+00	1.1E+01	2.7E-04	1.7E-03	1%	- -	- -	[B2]	1.7E-07	1.0E-06	5%
Benzo(a)pyrene	4.6E+00	1.1E+01	3.0E-04	1.8E-03	1%	- -	- -	[B2]	1.9E-06	1.1E-05	52%
Benzo(b)fluoranthene	7.5E+00	1.9E+01	4.9E-04	2.9E-03	1%	- -	- -	[B2]	3.1E-07	1.8E-06	9%
Benzo(g,h,i)perylene	4.2E+00	9.5E+00	2.8E-04	1.5E-03	1%	- -	- -	[D]			
Benzo(k)fluoranthene	2.6E+00	6.6E+00	1.7E-04	1.0E-03	0%	- -	- -	[B2]	1.1E-07	6.5E-07	3%
Carbazole	3.7E-01	8.2E-01				- -	- -	[B2]	4.1E-10	2.2E-09	0%
Chrysene	4.5E+00	1.1E+01	3.0E-04	1.7E-03	1%	- -	- -	[B2]	1.9E-08	1.1E-07	0%
Dibenzo(a,h)anthracene	1.2E+00	3.0E+00	7.8E-05	4.7E-04	0%	- -	- -	[B2]	4.9E-07	2.9E-06	14%
Dibenzofuran	1.7E-01	2.1E-01				- -	- -	[D]			
Di-n-octyl phthalate	1.4E-01	1.4E-01	1.4E-05	3.3E-05	0%	kidney, liver; inc. weight, inc. sgot and sgpt activity	1000	- -			
Fluoranthene	7.7E+00	1.7E+01	3.8E-04	2.0E-03	1%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Fluorene	2.5E-01	3.6E-01	1.2E-05	4.2E-05	0%	erythrocytes; dec. counts	3000	[D]			
Indeno(1,2,3-cd)pyrene	5.1E+00	1.2E+01	3.3E-04	1.9E-03	1%	- -	- -	[B2]	2.1E-07	1.2E-06	6%
2-Methylnaphthalene	7.4E-01	1.8E+00	4.8E-05	2.9E-04	0%	skin effects	- -	- -			
Naphthalene	2.7E-01	3.7E-01				dec. body weight	- -	[D]			
Phenanthrene	3.1E+00	6.4E+00	2.0E-04	1.0E-03	0%	- -	- -	[D]			
Pyrene	9.3E+00	2.1E+01	6.1E-04	3.3E-03	1%	kidney; red. weight, renal tubular pathology	3000	[D]			
Summed Hazard Quotient			MLE 8.94E-02	RME 2.93E-01	100%						
Summed Cancer Risk									MLE 4.11E-06	RME 2.15E-05	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-56. RISK FROM SOIL DERMAL CONTACT BY CONSTRUCTION WORKER - CURRENT CONDITIONS
SITE 5 - RAMP DRAINAGE DITCH, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Construction Zone Soil (mg/kg)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	5.1E-01	6.6E-01	1.2E-05	9.3E-05	2%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.4E+00	9.3E+00	2.7E-04	1.8E-03	31%	skin; keratosis, hyperpigmentation	3	[A]	4.1E-09	2.6E-08	1%
Beryllium	4.5E-01	5.0E-01	8.7E-07	5.7E-06	0%	no observed effects	100	[B2]	5.3E-10	3.5E-09	0%
Cadmium (food)	7.8E+00	1.6E+01	7.6E-05	8.9E-04	16%	kidney; proteinuria	10	- -			
Chromium (III)	6.6E+01	1.2E+02	6.5E-07	6.6E-06	0%	no observed effects	100	- -			
Copper	2.9E+01	4.2E+01	7.7E-06	6.5E-05	1%	Gastrointestinal system; irritation	- -	[D]			
Lead	1.3E+02	2.4E+02				CNS, blood	- -	[B2]			
Mercury	5.5E-02	9.0E-02	1.8E-06	1.7E-05	0%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	1.8E+01	2.2E+01	8.6E-06	6.2E-05	1%	dec. body and organ weight	300	- -			
Silver	1.3E+00	1.6E+00	2.5E-06	1.8E-05	0%	skin; argyria	3	[D]			
Thallium	3.2E-01	4.2E-01	3.9E-05	3.0E-04	5%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	2.5E+02	4.7E+02	8.2E-06	8.9E-05	2%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthene	2.3E-01	3.4E-01	3.8E-07	3.3E-06	0%	liver; hepatotoxicity	3000	- -			
Acetone	1.1E-02	1.6E-02	1.1E-08	9.1E-08	0%	inc. liver, kidney weights, nephrotoxicity	1000	[D]			
Anthracene	5.1E-01	1.0E+00	1.7E-07	2.0E-06	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	4.2E+00	1.1E+01	1.4E-05	2.0E-04	4%	- -	- -	[B2]	8.6E-09	1.3E-07	5%
Benzo(a)pyrene	4.6E+00	1.1E+01	1.5E-05	2.2E-04	4%	- -	- -	[B2]	9.4E-08	1.4E-06	58%
Benzo(b)fluoranthene	7.5E+00	1.9E+01	2.5E-05	3.6E-04	6%	- -	- -	[B2]	1.5E-08	2.2E-07	10%
Benzo(g,h,i)perylene	4.2E+00	9.5E+00	1.4E-05	1.8E-04	3%	- -	- -	[D]			
Benzo(k)fluoranthene	2.6E+00	6.6E+00	8.6E-06	1.3E-04	2%	- -	- -	[B2]	5.4E-09	7.8E-08	3%
Carbazole	3.7E-01	8.2E-01				- -	- -	[B2]	2.1E-11	2.6E-10	0%
Chrysene	4.5E+00	1.1E+01	1.5E-05	2.1E-04	4%	- -	- -	[B2]	9.3E-10	1.3E-08	1%
Dibenzo(a,h)anthracene	1.2E+00	3.0E+00	3.9E-06	5.6E-05	1%	- -	- -	[B2]	2.4E-08	3.5E-07	15%
Dibenzofuran	1.7E-01	2.1E-01				- -	- -	[D]			
Di-n-octyl phthalate	1.4E-01	1.4E-01	6.9E-07	4.0E-06	0%	kidney, liver; inc. weight, inc. sgot and sgpt activity	1000	- -			
Fluoranthene	7.7E+00	1.7E+01	1.9E-05	2.5E-04	4%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Fluorene	2.5E-01	3.6E-01	6.1E-07	5.1E-06	0%	erythrocytes; dec. counts	3000	[D]			
Indeno(1,2,3-cd)pyrene	5.1E+00	1.2E+01	1.7E-05	2.3E-04	4%	- -	- -	[B2]	1.0E-08	1.5E-07	6%
2-Methylnaphthalene	7.4E-01	1.8E+00	2.4E-06	3.5E-05	1%	skin effects	- -	- -			
Naphthalene	2.7E-01	3.7E-01				dec. body weight	- -	[D]			
Phenanthrene	3.1E+00	6.4E+00	1.0E-05	1.2E-04	2%	- -	- -	[D]			
Pyrene	9.3E+00	2.1E+01	3.0E-05	4.0E-04	7%	kidney; red. weight, renal tubular pathology	3000	[D]			
Summed Hazard Quotient			MLE 6.05E-04	RME 5.70E-03	100%						
Summed Cancer Risk									MLE 1.64E-07	RME 2.32E-06	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-57. RISK FROM SOIL INGESTION BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 5 - RAMP DRAINAGE DITCH, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg) MLE	Exposure Point Concentration in Surface Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	5.1E-01	6.6E-01	1.3E-02	2.1E-02	3%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.4E+00	9.3E+00	2.8E-01	4.0E-01	50%	skin; keratosis, hyperpigmentation	3	[A]	1.3E-05	1.8E-05	10%
Beryllium	4.5E-01	5.0E-01	8.9E-04	1.3E-03	0%	no observed effects	100	[B2]	1.6E-06	2.4E-06	1%
Cadmium (food)	7.8E+00	1.6E+01	7.8E-02	2.0E-01	25%	kidney; proteinuria	10	- -			
Chromium (III)	6.6E+01	1.2E+02	6.6E-04	1.5E-03	0%	no observed effects	100	- -			
Copper	2.9E+01	4.2E+01	7.9E-03	1.5E-02	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	1.3E+02	2.4E+02				CNS, blood	- -	[B2]			
Mercury	5.5E-02	9.0E-02	1.8E-03	3.8E-03	0%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	1.8E+01	2.2E+01	8.8E-03	1.4E-02	2%	dec. body and organ weight	300	- -			
Silver	1.3E+00	1.6E+00	2.6E-03	4.1E-03	1%	skin; argyria	3	[D]			
Thallium	3.2E-01	4.2E-01	4.0E-02	6.7E-02	8%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	2.5E+02	4.7E+02	8.4E-03	2.0E-02	3%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthene	2.3E-01	3.4E-01	3.9E-05	7.3E-05	0%	liver; hepatotoxicity	3000	- -			
Acetone	1.1E-02	1.6E-02	1.1E-06	2.0E-06	0%	inc. liver, kidney weights, nephrotoxicity	1000	[D]			
Anthracene	5.1E-01	1.0E+00	1.7E-05	4.4E-05	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	4.2E+00	1.1E+01	1.4E-03	4.5E-03	1%	- -	- -	[B2]	2.6E-06	8.5E-06	5%
Benzo(a)pyrene	4.6E+00	1.1E+01	1.5E-03	4.9E-03	1%	- -	- -	[B2]	2.9E-05	9.2E-05	52%
Benzo(b)fluoranthene	7.5E+00	1.9E+01	2.5E-03	8.0E-03	1%	- -	- -	[B2]	4.7E-06	1.5E-05	9%
Benzo(g,h,i)perylene	4.2E+00	9.5E+00	1.4E-03	4.1E-03	1%	- -	- -	[D]			
Benzo(k)fluoranthene	2.6E+00	6.6E+00	8.8E-04	2.8E-03	0%	- -	- -	[B2]	1.7E-06	5.3E-06	3%
Carbazole	3.7E-01	8.2E-01				- -	- -	[B2]	6.3E-09	1.8E-08	0%
Chrysene	4.5E+00	1.1E+01	1.5E-03	4.7E-03	1%	- -	- -	[B2]	2.9E-07	8.8E-07	0%
Dibenzo(a,h)anthracene	1.2E+00	3.0E+00	4.0E-04	1.3E-03	0%	- -	- -	[B2]	7.5E-06	2.4E-05	14%
Dibenzofuran	1.7E-01	2.1E-01				- -	- -	[D]			
Di-n-octyl phthalate	1.4E-01	1.4E-01	7.1E-05	9.1E-05	0%	kidney, liver; inc. weight, inc. sgot and sgpt activity	1000	- -			
Fluoranthene	7.7E+00	1.7E+01	1.9E-03	5.5E-03	1%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Fluorene	2.5E-01	3.6E-01	6.3E-05	1.2E-04	0%	erythrocytes; dec. counts	3000	[D]			
Indeno(1,2,3-cd)pyrene	5.1E+00	1.2E+01	1.7E-03	5.3E-03	1%	- -	- -	[B2]	3.2E-06	9.9E-06	6%
2-Methylnaphthalene	7.4E-01	1.8E+00	2.5E-04	7.8E-04	0%	skin effects	- -	- -			
Naphthalene	2.7E-01	3.7E-01				dec. body weight	- -	[D]			
Phenanthrene	3.1E+00	6.4E+00	1.0E-03	2.7E-03	0%	- -	- -	[D]			
Pyrene	9.3E+00	2.1E+01	3.1E-03	9.1E-03	1%	kidney; red. weight, renal tubular pathology	3000	[D]			
Summed Hazard Quotient			MLE 4.59E-01	RME 7.97E-01	100%						
Summed Cancer Risk									MLE 6.33E-05	RME 1.75E-04	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-58. RISK FROM SOIL INHALATION BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 5 - RAMP DRAINAGE DITCH, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg) MLE	Exposure Point Concentration in Surface Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (inhalation)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	5.1E-01	6.6E-01				whole body, blood; inc. mortality	- -	- -			
Arsenic	8.4E+00	9.3E+00				skin; keratosis, hyperpigmentation	- -	[A]	7.8E-09	1.1E-08	82%
Beryllium	4.5E-01	5.0E-01				no observed effects	- -	[B2]	7.0E-11	9.9E-11	1%
Cadmium (food)	7.8E+00	1.6E+01				kidney; proteinuria	- -	- -	8.8E-10	2.3E-09	17%
Chromium (III)	6.6E+01	1.2E+02				no observed effects	- -	- -			
Copper	2.9E+01	4.2E+01				Gastrointestinal system; irritation	- -	[D]			
Lead	1.3E+02	2.4E+02				CNS, blood	- -	[B2]			
Mercury	5.5E-02	9.0E-02	1.4E-07	2.9E-07	100%	oral-CNS; neurotoxicity. inhal.-kidney effects	30	[D]			
Nickel	1.8E+01	2.2E+01				dec. body and organ weight	- -	- -			
Silver	1.3E+00	1.6E+00				skin; argyria	- -	[D]			
Thallium	3.2E-01	4.2E-01				liver, blood; inc. sgot and serum LDH	- -	[D]			
Zinc	2.5E+02	4.7E+02				blood; anemia	- -	[D]			
ORGANICS											
Acenaphthene	2.3E-01	3.4E-01				liver; hepatotoxicity	- -	- -			
Acetone	1.1E-02	1.6E-02				inc. liver, kidney weights, nephrotoxicity	- -	[D]			
Anthracene	5.1E-01	1.0E+00				no observed effects	- -	[D]			
Benzo(a)anthracene	4.2E+00	1.1E+01				- -	- -	[B2]			
Benzo(a)pyrene	4.6E+00	1.1E+01				- -	- -	[B2]			
Benzo(b)fluoranthene	7.5E+00	1.9E+01				- -	- -	[B2]			
Benzo(g,h,i)perylene	4.2E+00	9.5E+00				- -	- -	[D]			
Benzo(k)fluoranthene	2.6E+00	6.6E+00				- -	- -	[B2]			
Carbazole	3.7E-01	8.2E-01				- -	- -	[B2]			
Chrysene	4.5E+00	1.1E+01				- -	- -	[B2]			
Dibenzo(a,h)anthracene	1.2E+00	3.0E+00				- -	- -	[B2]			
Dibenzofuran	1.7E-01	2.1E-01				- -	- -	[D]			
Di-n-octyl phthalate	1.4E-01	1.4E-01				kidney, liver; inc. weight, inc. sgot and sgpt activity	- -	- -			
Fluoranthene	7.7E+00	1.7E+01				kidney, liver, blood; inc. weight, hematological changes	- -	[D]			
Fluorene	2.5E-01	3.6E-01				erythrocytes; dec. counts	- -	[D]			
Indeno(1,2,3-cd)pyrene	5.1E+00	1.2E+01				- -	- -	[B2]			
2-Methylnaphthalene	7.4E-01	1.8E+00				skin effects	- -	- -			
Naphthalene	2.7E-01	3.7E-01				dec. body weight	- -	[D]			
Phenanthrene	3.1E+00	6.4E+00				- -	- -	[D]			
Pyrene	9.3E+00	2.1E+01				kidney; red. weight, renal tubular pathology	- -	[D]			
Summed Hazard Quotient			MLE 1.39E-07	RME 2.90E-07	100%						
Summed Cancer Risk									MLE 8.72E-09	RME 1.34E-08	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-59. RISK FROM SOIL DERMAL CONTACT BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 5 - RAMP DRAINAGE DITCH, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg) MLE	RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	RME	RME % of total ELCR
INORGANICS											
Antimony	5.1E-01	6.6E-01	2.2E-05	2.1E-04	2%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.4E+00	9.3E+00	4.9E-04	4.0E-03	31%	skin; keratosis, hyperpigmentation	3	[A]	2.2E-08	1.8E-07	1%
Beryllium	4.5E-01	5.0E-01	1.6E-06	1.3E-05	0%	no observed effects	100	[B2]	2.9E-09	2.4E-08	0%
Cadmium (food)	7.8E+00	1.6E+01	1.4E-04	2.0E-03	16%	kidney; proteinuria	10	- -			
Chromium (III)	6.6E+01	1.2E+02	1.2E-06	1.5E-05	0%	no observed effects	100	- -			
Copper	2.9E+01	4.2E+01	1.4E-05	1.5E-04	1%	Gastrointestinal system; irritation	- -	[D]			
Lead	1.3E+02	2.4E+02				CNS, blood	- -	[B2]			
Mercury	5.5E-02	9.0E-02	3.2E-06	3.9E-05	0%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	1.8E+01	2.2E+01	1.5E-05	1.4E-04	1%	dec. body and organ weight	300	- -			
Silver	1.3E+00	1.6E+00	4.5E-06	4.1E-05	0%	skin; argyria	3	[D]			
Thallium	3.2E-01	4.2E-01	6.9E-05	6.7E-04	5%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	2.5E+02	4.7E+02	1.5E-05	2.0E-04	2%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthene	2.3E-01	3.4E-01	6.8E-07	7.4E-06	0%	liver; hepatotoxicity	3000	- -			
Acetone	1.1E-02	1.6E-02	1.9E-08	2.1E-07	0%	inc. liver, kidney weights, nephrotoxicity	1000	[D]			
Anthracene	5.1E-01	1.0E+00	3.0E-07	4.5E-06	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	4.2E+00	1.1E+01	2.5E-05	4.6E-04	4%	- -	- -	[B2]	4.6E-08	8.6E-07	5%
Benzo(a)pyrene	4.6E+00	1.1E+01	2.7E-05	4.9E-04	4%	- -	- -	[B2]	5.1E-07	9.2E-06	58%
Benzo(b)fluoranthene	7.5E+00	1.9E+01	4.4E-05	8.1E-04	6%	- -	- -	[B2]	8.3E-08	1.5E-06	10%
Benzo(g,h,i)perylene	4.2E+00	9.5E+00	2.5E-05	4.1E-04	3%	- -	- -	[D]			
Benzo(k)fluoranthene	2.6E+00	6.6E+00	1.5E-05	2.8E-04	2%	- -	- -	[B2]	2.9E-08	5.3E-07	3%
Carbazole	3.7E-01	8.2E-01				- -	- -	[B2]	1.1E-10	1.8E-09	0%
Chrysene	4.5E+00	1.1E+01	2.7E-05	4.7E-04	4%	- -	- -	[B2]	5.0E-09	8.8E-08	1%
Dibenzo(a,h)anthracene	1.2E+00	3.0E+00	7.0E-06	1.3E-04	1%	- -	- -	[B2]	1.3E-07	2.4E-06	15%
Dibenzofuran	1.7E-01	2.1E-01				- -	- -	[D]			
Di-n-octyl phthalate	1.4E-01	1.4E-01	1.2E-06	9.1E-06	0%	kidney, liver; inc. weight, inc. sgot and sgpt activity	1000	- -			
Fluoranthene	7.7E+00	1.7E+01	3.4E-05	5.6E-04	4%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Fluorene	2.5E-01	3.6E-01	1.1E-06	1.2E-05	0%	erythrocytes; dec. counts	3000	[D]			
Indeno(1,2,3-cd)pyrene	5.1E+00	1.2E+01	3.0E-05	5.3E-04	4%	- -	- -	[B2]	5.6E-08	9.9E-07	6%
2-Methylnaphthalene	7.4E-01	1.8E+00	4.3E-06	7.9E-05	1%	skin effects	- -	- -			
Naphthalene	2.7E-01	3.7E-01				dec. body weight	- -	[D]			
Phenanthrene	3.1E+00	6.4E+00	1.8E-05	2.7E-04	2%	- -	- -	[D]			
Pyrene	9.3E+00	2.1E+01	5.5E-05	9.2E-04	7%	kidney; red. weight, renal tubular pathology	3000	[D]			
Summed Hazard Quotient			MLE 1.09E-03	RME 1.29E-02	100%						
Summed Cancer Risk									MLE 8.84E-07	RME 1.58E-05	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-60. RISK FROM VAPOR INHALATION BY RESIDENT CHILD - FUTURE CONDITIONS
SITE 5 - RAMP DRAINAGE DITCH, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg) MLE	RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	RME	RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	RME	RME % of total ELCR
INORGANICS											
Antimony	5.1E-01	6.6E-01				whole body, blood; inc. mortality	--	--			
Arsenic	8.4E+00	9.3E+00				skin; keratosis, hyperpigmentation	--	[A]			
Beryllium	4.5E-01	5.0E-01				no observed effects	--	[B2]			
Cadmium (food)	7.8E+00	1.6E+01				kidney; proteinuria	--	--			
Chromium (III)	6.6E+01	1.2E+02				no observed effects	--	--			
Copper	2.9E+01	4.2E+01				Gastrointestinal system; irritation	--	[D]			
Lead	1.3E+02	2.4E+02				CNS, blood	--	[B2]			
Mercury	5.5E-02	9.0E-02				oral-CNS; neurotoxicity. inhal.-kidney effects	30	[D]			
Nickel	1.8E+01	2.2E+01				dec. body and organ weight	--	--			
Silver	1.3E+00	1.6E+00				skin; argyria	--	[D]			
Thallium	3.2E-01	4.2E-01				liver, blood; inc. sgot and serum LDH	--	[D]			
Zinc	2.5E+02	4.7E+02				blood; anemia	--	[D]			
ORGANICS											
Acenaphthene	2.3E-01	3.4E-01				liver; hepatotoxicity	--	--			
Acetone	1.1E-02	1.6E-02				inc. liver, kidney weights, nephrotoxicity	--	[D]			
Anthracene	5.1E-01	1.0E+00				no observed effects	--	[D]			
Benzo(a)anthracene	4.2E+00	1.1E+01				--	--	[B2]			
Benzo(a)pyrene	4.6E+00	1.1E+01				--	--	[B2]			
Benzo(b)fluoranthene	7.5E+00	1.9E+01				--	--	[B2]			
Benzo(g,h,i)perylene	4.2E+00	9.5E+00				--	--	[D]			
Benzo(k)fluoranthene	2.6E+00	6.6E+00				--	--	[B2]			
Carbazole	3.7E-01	8.2E-01				--	--	[B2]			
Chrysene	4.5E+00	1.1E+01				--	--	[B2]			
Dibenzo(a,h)anthracene	1.2E+00	3.0E+00				--	--	[B2]			
Dibenzofuran	1.7E-01	2.1E-01				--	--	[D]			
Di-n-octyl phthalate	1.4E-01	1.4E-01				kidney, liver; inc. weight, inc. sgot and sgpt activity	--	--			
Fluoranthene	7.7E+00	1.7E+01				kidney, liver, blood; inc. weight, hematological changes	--	[D]			
Fluorene	2.5E-01	3.6E-01				erythrocytes; dec. counts	--	[D]			
Indeno(1,2,3-cd)pyrene	5.1E+00	1.2E+01				--	--	[B2]			
2-Methylnaphthalene	7.4E-01	1.8E+00				skin effects	--	--			
Naphthalene	2.7E-01	3.7E-01				dec. body weight	--	[D]			
Phenanthrene	3.1E+00	6.4E+00				--	--	[D]			
Pyrene	9.3E+00	2.1E+01				kidney; red. weight, renal tubular pathology	--	[D]			

	MLE	RME
Summed Hazard Quotient	--	--

	MLE	RME
Summed Cancer Risk	--	--

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-61. RISK FROM SOIL INGESTION BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 5 - RAMP DRAINAGE DITCH, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	5.1E-01	6.6E-01	1.4E-03	2.2E-03	3%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.4E+00	9.3E+00	3.0E-02	4.3E-02	50%	skin; keratosis, hyperpigmentation	3	[A]	2.0E-06	7.7E-06	10%
Beryllium	4.5E-01	5.0E-01	9.6E-05	1.4E-04	0%	no observed effects	100	[B2]	2.6E-07	1.0E-06	1%
Cadmium (food)	7.8E+00	1.6E+01	8.4E-03	2.1E-02	25%	kidney; proteinuria	10	- -			
Chromium (III)	6.6E+01	1.2E+02	7.1E-05	1.6E-04	0%	no observed effects	100	- -			
Copper	2.9E+01	4.2E+01	8.4E-04	1.6E-03	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	1.3E+02	2.4E+02				CNS, blood	- -	[B2]			
Mercury	5.5E-02	9.0E-02	2.0E-04	4.1E-04	0%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	1.8E+01	2.2E+01	9.5E-04	1.5E-03	2%	dec. body and organ weight	300	- -			
Silver	1.3E+00	1.6E+00	2.7E-04	4.4E-04	1%	skin; argyria	3	[D]			
Thallium	3.2E-01	4.2E-01	4.2E-03	7.2E-03	8%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	2.5E+02	4.7E+02	9.0E-04	2.1E-03	3%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthene	2.3E-01	3.4E-01	4.1E-06	7.9E-06	0%	liver; hepatotoxicity	3000	- -			
Acetone	1.1E-02	1.6E-02	1.2E-07	2.2E-07	0%	inc. liver, kidney weights, nephrotoxicity	1000	[D]			
Anthracene	5.1E-01	1.0E+00	1.8E-06	4.8E-06	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	4.2E+00	1.1E+01	1.5E-04	4.9E-04	1%	- -	- -	[B2]	4.3E-07	3.7E-06	5%
Benzo(a)pyrene	4.6E+00	1.1E+01	1.7E-04	5.2E-04	1%	- -	- -	[B2]	4.7E-06	3.9E-05	52%
Benzo(b)fluoranthene	7.5E+00	1.9E+01	2.7E-04	8.6E-04	1%	- -	- -	[B2]	7.6E-07	6.4E-06	9%
Benzo(g,h,i)perylene	4.2E+00	9.5E+00	1.5E-04	4.3E-04	1%	- -	- -	[D]			
Benzo(k)fluoranthene	2.6E+00	6.6E+00	9.5E-05	3.0E-04	0%	- -	- -	[B2]	2.7E-07	2.3E-06	3%
Carbazole	3.7E-01	8.2E-01				- -	- -	[B2]	1.0E-09	7.7E-09	0%
Chrysene	4.5E+00	1.1E+01	1.6E-04	5.0E-04	1%	- -	- -	[B2]	4.6E-08	3.8E-07	0%
Dibenzo(a,h)anthracene	1.2E+00	3.0E+00	4.3E-05	1.4E-04	0%	- -	- -	[B2]	1.2E-06	1.0E-05	14%
Dibenzofuran	1.7E-01	2.1E-01				- -	- -	[D]			
Di-n-octyl phthalate	1.4E-01	1.4E-01	7.6E-06	9.7E-06	0%	kidney, liver; inc. weight, inc. sgot and sgpt activity	1000	- -			
Fluoranthene	7.7E+00	1.7E+01	2.1E-04	5.9E-04	1%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Fluorene	2.5E-01	3.6E-01	6.7E-06	1.2E-05	0%	erythrocytes; dec. counts	3000	[D]			
Indeno(1,2,3-cd)pyrene	5.1E+00	1.2E+01	1.8E-04	5.6E-04	1%	- -	- -	[B2]	5.2E-07	4.2E-06	6%
2-Methylnaphthalene	7.4E-01	1.8E+00	2.7E-05	8.4E-05	0%	skin effects	- -	- -			
Naphthalene	2.7E-01	3.7E-01				dec. body weight	- -	[D]			
Phenanthrene	3.1E+00	6.4E+00	1.1E-04	2.9E-04	0%	- -	- -	[D]			
Pyrene	9.3E+00	2.1E+01	3.4E-04	9.8E-04	1%	kidney; red. weight, renal tubular pathology	3000	[D]			
Summed Hazard Quotient			MLE 4.92E-02	RME 8.54E-02	100%						
Summed Cancer Risk									MLE 1.02E-05	RME 7.51E-05	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-62. RISK FROM SOIL INHALATION BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 5 - RAMP DRAINAGE DITCH, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	5.1E-01	6.6E-01				whole body, blood; inc. mortality	--	--			
Arsenic	8.4E+00	9.3E+00				skin; keratosis, hyperpigmentation	--	[A]	2.5E-09	1.2E-08	82%
Beryllium	4.5E-01	5.0E-01				no observed effects	--	[B2]	2.2E-11	1.1E-10	1%
Cadmium (food)	7.8E+00	1.6E+01				kidney; proteinuria	--	--	2.8E-10	2.4E-09	17%
Chromium (III)	6.6E+01	1.2E+02				no observed effects	--	--			
Copper	2.9E+01	4.2E+01				Gastrointestinal system; irritation	--	[D]			
Lead	1.3E+02	2.4E+02				CNS, blood	--	[B2]			
Mercury	5.5E-02	9.0E-02	3.0E-08	6.2E-08	100%	oral-CNS; neurotoxicity. inhal.-kidney effects	30	[D]			
Nickel	1.8E+01	2.2E+01				dec. body and organ weight	--	--			
Silver	1.3E+00	1.6E+00				skin; argyria	--	[D]			
Thallium	3.2E-01	4.2E-01				liver, blood; inc. sgot and serum LDH	--	[D]			
Zinc	2.5E+02	4.7E+02				blood; anemia	--	[D]			
ORGANICS											
Acenaphthene	2.3E-01	3.4E-01				liver; hepatotoxicity	--	--			
Acetone	1.1E-02	1.6E-02				inc. liver, kidney weights, nephrotoxicity	--	[D]			
Anthracene	5.1E-01	1.0E+00				no observed effects	--	[D]			
Benzo(a)anthracene	4.2E+00	1.1E+01				--	--	[B2]			
Benzo(a)pyrene	4.6E+00	1.1E+01				--	--	[B2]			
Benzo(b)fluoranthene	7.5E+00	1.9E+01				--	--	[B2]			
Benzo(g,h,i)perylene	4.2E+00	9.5E+00				--	--	[D]			
Benzo(k)fluoranthene	2.6E+00	6.6E+00				--	--	[B2]			
Carbazole	3.7E-01	8.2E-01				--	--	[B2]			
Chrysene	4.5E+00	1.1E+01				--	--	[B2]			
Dibenzo(a,h)anthracene	1.2E+00	3.0E+00				--	--	[B2]			
Dibenzofuran	1.7E-01	2.1E-01				--	--	[D]			
Di-n-octyl phthalate	1.4E-01	1.4E-01				kidney, liver; inc. weight, inc. sgot and sgpt activity	--	--			
Fluoranthene	7.7E+00	1.7E+01				kidney, liver, blood; inc. weight, hematological changes	--	[D]			
Fluorene	2.5E-01	3.6E-01				erythrocytes; dec. counts	--	[D]			
Indeno(1,2,3-cd)pyrene	5.1E+00	1.2E+01				--	--	[B2]			
2-Methylnaphthalene	7.4E-01	1.8E+00				skin effects	--	--			
Naphthalene	2.7E-01	3.7E-01				dec. body weight	--	[D]			
Phenanthrene	3.1E+00	6.4E+00				--	--	[D]			
Pyrene	9.3E+00	2.1E+01				kidney; red. weight, renal tubular pathology	--	[D]			

Summed Hazard Quotient	MLE	RME	
	2.98E-08	6.21E-08	100%

Summed Cancer Risk	MLE	RME	
	2.80E-09	1.43E-08	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-63. RISK FROM SOIL DERMAL CONTACT BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 5 - RAMP DRAINAGE DITCH, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	5.1E-01	6.6E-01	1.4E-05	1.3E-04	2%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.4E+00	9.3E+00	3.0E-04	2.5E-03	31%	skin; keratosis, hyperpigmentation	3	[A]	2.0E-08	5.5E-07	1%
Beryllium	4.5E-01	5.0E-01	9.6E-07	7.9E-06	0%	no observed effects	100	[B2]	2.6E-09	7.3E-08	0%
Cadmium (food)	7.8E+00	1.6E+01	8.4E-05	1.2E-03	16%	kidney; proteinuria	10	- -			
Chromium (III)	6.6E+01	1.2E+02	7.1E-07	9.3E-06	0%	no observed effects	100	- -			
Copper	2.9E+01	4.2E+01	8.4E-06	9.0E-05	1%	Gastrointestinal system; irritation	- -	[D]			
Lead	1.3E+02	2.4E+02				CNS, blood	- -	[B2]			
Mercury	5.5E-02	9.0E-02	2.0E-06	2.4E-05	0%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	1.8E+01	2.2E+01	9.5E-06	8.7E-05	1%	dec. body and organ weight	300	- -			
Silver	1.3E+00	1.6E+00	2.7E-06	2.5E-05	0%	skin; argyria	3	[D]			
Thallium	3.2E-01	4.2E-01	4.2E-05	4.2E-04	5%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	2.5E+02	4.7E+02	9.0E-06	1.2E-04	2%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthene	2.3E-01	3.4E-01	4.1E-07	4.6E-06	0%	liver; hepatotoxicity	3000	- -			
Acetone	1.1E-02	1.6E-02	1.2E-08	1.3E-07	0%	inc. liver, kidney weights, nephrotoxicity	1000	[D]			
Anthracene	5.1E-01	1.0E+00	1.8E-07	2.8E-06	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	4.2E+00	1.1E+01	1.5E-05	2.8E-04	4%	- -	- -	[B2]	4.3E-08	2.6E-06	5%
Benzo(a)pyrene	4.6E+00	1.1E+01	1.7E-05	3.0E-04	4%	- -	- -	[B2]	4.7E-07	2.8E-05	58%
Benzo(b)fluoranthene	7.5E+00	1.9E+01	2.7E-05	5.0E-04	6%	- -	- -	[B2]	7.6E-08	4.7E-06	10%
Benzo(g,h,i)perylene	4.2E+00	9.5E+00	1.5E-05	2.5E-04	3%	- -	- -	[D]			
Benzo(k)fluoranthene	2.6E+00	6.6E+00	9.5E-06	1.8E-04	2%	- -	- -	[B2]	2.7E-08	1.6E-06	3%
Carbazole	3.7E-01	8.2E-01				- -	- -	[B2]	1.0E-10	5.6E-09	0%
Chrysene	4.5E+00	1.1E+01	1.6E-05	2.9E-04	4%	- -	- -	[B2]	4.6E-09	2.7E-07	1%
Dibenzo(a,h)anthracene	1.2E+00	3.0E+00	4.3E-06	7.9E-05	1%	- -	- -	[B2]	1.2E-07	7.4E-06	15%
Dibenzofuran	1.7E-01	2.1E-01				- -	- -	[D]			
Di-n-octyl phthalate	1.4E-01	1.4E-01	7.6E-07	5.6E-06	0%	kidney, liver; inc. weight, inc. sgot and sgpt activity	1000	- -			
Fluoranthene	7.7E+00	1.7E+01	2.1E-05	3.4E-04	4%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Fluorene	2.5E-01	3.6E-01	6.7E-07	7.2E-06	0%	erythrocytes; dec. counts	3000	[D]			
Indeno(1,2,3-cd)pyrene	5.1E+00	1.2E+01	1.8E-05	3.3E-04	4%	- -	- -	[B2]	5.2E-08	3.1E-06	6%
2-Methylnaphthalene	7.4E-01	1.8E+00	2.7E-06	4.9E-05	1%	skin effects	- -	- -			
Naphthalene	2.7E-01	3.7E-01				dec. body weight	- -	[D]			
Phenanthrene	3.1E+00	6.4E+00	1.1E-05	1.7E-04	2%	- -	- -	[D]			
Pyrene	9.3E+00	2.1E+01	3.4E-05	5.7E-04	7%	kidney; red. weight, renal tubular pathology	3000	[D]			
Summed Hazard Quotient			MLE 6.65E-04	RME 7.97E-03	100%						
Summed Cancer Risk									MLE 8.12E-07	RME 4.88E-05	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-64. RISK FROM VAPOR INHALATION BY RESIDENT ADULT - FUTURE CONDITIONS
SITE 5 - RAMP DRAINAGE DITCH, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg) MLE	Exposure Point Concentration in Surface Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	5.1E-01	6.6E-01				whole body, blood; inc. mortality	--	--			
Arsenic	8.4E+00	9.3E+00				skin; keratosis, hyperpigmentation	--	[A]			
Beryllium	4.5E-01	5.0E-01				no observed effects	--	[B2]			
Cadmium (food)	7.8E+00	1.6E+01				kidney; proteinuria	--	--			
Chromium (III)	6.6E+01	1.2E+02				no observed effects	--	--			
Copper	2.9E+01	4.2E+01				Gastrointestinal system; irritation	--	[D]			
Lead	1.3E+02	2.4E+02				CNS, blood	--	[B2]			
Mercury	5.5E-02	9.0E-02				oral-CNS; neurotoxicity. inhal.-kidney effects	30	[D]			
Nickel	1.8E+01	2.2E+01				dec. body and organ weight	--	--			
Silver	1.3E+00	1.6E+00				skin; argyria	--	[D]			
Thallium	3.2E-01	4.2E-01				liver, blood; inc. sgot and serum LDH	--	[D]			
Zinc	2.5E+02	4.7E+02				blood; anemia	--	[D]			
ORGANICS											
Acenaphthene	2.3E-01	3.4E-01				liver; hepatotoxicity	--	--			
Acetone	1.1E-02	1.6E-02				inc. liver, kidney weights, nephrotoxicity	--	[D]			
Anthracene	5.1E-01	1.0E+00				no observed effects	--	[D]			
Benzo(a)anthracene	4.2E+00	1.1E+01				--	--	[B2]			
Benzo(a)pyrene	4.6E+00	1.1E+01				--	--	[B2]			
Benzo(b)fluoranthene	7.5E+00	1.9E+01				--	--	[B2]			
Benzo(g,h,i)perylene	4.2E+00	9.5E+00				--	--	[D]			
Benzo(k)fluoranthene	2.6E+00	6.6E+00				--	--	[B2]			
Carbazole	3.7E-01	8.2E-01				--	--	[B2]			
Chrysene	4.5E+00	1.1E+01				--	--	[B2]			
Dibenzo(a,h)anthracene	1.2E+00	3.0E+00				--	--	[B2]			
Dibenzofuran	1.7E-01	2.1E-01				--	--	[D]			
Di-n-octyl phthalate	1.4E-01	1.4E-01				kidney, liver; inc. weight, inc. sgot and sgpt activity	--	--			
Fluoranthene	7.7E+00	1.7E+01				kidney, liver, blood; inc. weight, hematological changes	--	[D]			
Fluorene	2.5E-01	3.6E-01				erythrocytes; dec. counts	--	[D]			
Indeno(1,2,3-cd)pyrene	5.1E+00	1.2E+01				--	--	[B2]			
2-Methylnaphthalene	7.4E-01	1.8E+00				skin effects	--	--			
Naphthalene	2.7E-01	3.7E-01				dec. body weight	--	[D]			
Phenanthrene	3.1E+00	6.4E+00				--	--	[D]			
Pyrene	9.3E+00	2.1E+01				kidney; red. weight, renal tubular pathology	--	[D]			

Summed Hazard Quotient	MLE	RME
	--	--

Summed Cancer Risk	MLE	RME
	--	--

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

Table H-65. Risk Estimate Summary - RME Risks
Background
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

CURRENT - OCCUPATIONAL

MEDIA	ROUTE	BASE PERSONNEL				CONSTRUCTION WORKER			
		Noncancer		Cancer		Noncancer		Cancer	
Soil	Ingestion	1.7E-02	B	3.1E-06	W	2.1E-01	B	3.0E-06	W
	Dermal	1.0E-03	B	3.4E-07	B	2.6E-03	B	6.8E-08	B
Soil Total	**Combined**	**1.8E-02**	B	**3.4E-06**	W	**2.1E-01**	B	**3.0E-06**	W

TOTAL	**1.8E-02**	B	**3.4E-06**	W	**2.1E-01**	B	**3.0E-06**	W

FUTURE - RESIDENTIAL

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Soil	Ingestion	5.7E-01	B	2.4E-05	W	6.1E-02	B	1.0E-05	W
	Inhalation	8.8E-07	B	1.2E-08	B	1.9E-07	B	1.3E-08	B
	Dermal	5.8E-03	B	4.6E-07	B	3.6E-03	B	1.4E-06	W
Soil Total	**Combined**	**5.8E-01**	B	**2.5E-05**	W	**6.5E-02**	B	**1.2E-05**	W

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Air (vapors) Total	**Inhalation**	**3.4E-05**	B	--	--	**7.4E-06**	B	--	--

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Groundwater	Ingestion	3.7E+00	E	1.8E-04	E	1.6E+00	E	3.9E-04	E
	Inhalation	--	--	--	--	--	--	--	--
	Dermal	4.3E-03	B	2.4E-07	B	2.3E-03	B	6.4E-07	B
GW Total	**Combined**	**3.7E+00**	E	**1.8E-04**	E	**1.6E+00**	E	**3.9E-04**	E

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Filtered Groundwater	Ingestion	3.0E-01	B	--	--	1.3E-01	B	--	--
	Inhalation	--	--	--	--	--	--	--	--
	Dermal	4.0E-04	B	--	--	2.2E-04	B	--	--
FGW Total	**Combined**	**3.0E-01**	B	--	--	**1.3E-01**	B	--	--

TOTAL	**4.3E+00**	E	**2.1E-04**	E	**1.6E+00**	E	**4.0E-04**	E

"B" - Below EPA human noncancer health effects target (HI < 1) or cancer risk (ELCR < 1 x 10-6)
"W" - Within EPA target cancer risk range (ELCR <= 1 x 10-4 and >= 1 x 10-6)
"E" - Exceeds EPA human noncancer health effects target (HI > 1) or cancer risks (ELCR > 1 x 10E-4)
-- No results are available for this route because detected chemicals do not easily volatilize and/or have no EPA-approved toxicity values

TABLE H-66. RISK FROM SOIL INGESTION BY BASE PERSONNEL - CURRENT CONDITIONS
BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg) MLE	Exposure Point Concentration in Surface Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	1.2E-01	1.7E-01	2.9E-05	1.7E-04	1%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.4E+00	1.0E+01	2.8E-03	1.3E-02	76%	skin; keratosis, hyperpigmentation	3	[A]	5.2E-07	2.5E-06	80%
Beryllium	4.1E-01	5.3E-01	8.1E-06	4.1E-05	0%	no observed effects	100	[B2]	6.2E-08	3.2E-07	10%
Cadmium (food)	3.9E-01	8.5E-01	3.9E-05	3.3E-04	2%	kidney; proteinuria	10	- -			
Chromium (III)	3.0E+01	6.7E+01	2.9E-06	2.6E-05	0%	no observed effects	100	- -			
Copper	2.1E+01	3.2E+01	5.5E-05	3.4E-04	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.3E+01	7.0E+01				CNS, blood	- -	[B2]			
Mercury	1.2E-01	2.7E-01	3.8E-05	3.5E-04	2%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	2.3E+01	3.9E+01	1.1E-04	7.5E-04	4%	dec. body and organ weight	300	- -			
Selenium	1.1E-01	1.8E-01	2.2E-06	1.4E-05	0%	whole body; clinical selenosis	3	[D]			
Silver	1.7E+00	3.2E+00	3.4E-05	2.5E-04	1%	skin; argyria	3	[D]			
Thallium	2.4E-01	3.4E-01	3.0E-04	1.7E-03	10%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	1.0E+02	2.0E+02	3.3E-05	2.6E-04	1%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthylene	1.1E-01	1.1E-01	3.6E-07	1.4E-06	0%	- -	- -	[D]			
Anthracene	1.2E-01	1.2E-01	3.8E-08	1.5E-07	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	1.8E-01	2.0E-01	6.0E-07	2.6E-06	0%	- -	- -	[B2]	4.7E-09	2.0E-08	1%
Benzo(a)pyrene	1.9E-01	2.0E-01	6.1E-07	2.7E-06	0%	- -	- -	[B2]	4.8E-08	2.1E-07	7%
Benzo(b)fluoranthene	2.3E-01	3.4E-01	7.4E-07	4.5E-06	0%	- -	- -	[B2]	5.8E-09	3.5E-08	1%
Benzo(g,h,i)perylene	1.9E-01	2.0E-01	6.1E-07	2.6E-06	0%	- -	- -	[D]			
Benzo(k)fluoranthene	1.5E-01	1.5E-01	5.0E-07	2.0E-06	0%	- -	- -	[B2]	3.9E-09	1.6E-08	1%
Carbazole	1.1E-01	1.1E-01				- -	- -	[B2]	7.8E-11	3.1E-10	0%
Chrysene	2.0E-01	2.2E-01	6.4E-07	2.9E-06	0%	- -	- -	[B2]	5.0E-10	2.3E-09	0%
Ethylbenzene	5.8E-03	6.1E-03	5.7E-09	2.4E-08	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	2.2E-01	3.3E-01	5.5E-07	3.2E-06	0%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Indeno(1,2,3-cd)pyrene	2.0E-01	2.4E-01	6.6E-07	3.1E-06	0%	- -	- -	[B2]	5.2E-09	2.4E-08	1%
Phenanthrene	1.8E-01	2.2E-01	5.9E-07	2.9E-06	0%	- -	- -	[D]			
Pyrene	2.2E-01	3.3E-01	7.3E-07	4.3E-06	0%	kidney; red. weight, renal tubular pathology	3000	[D]			
Toluene	6.8E-03	8.9E-03	3.3E-09	1.7E-08	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	1000	[D]			
Xylenes	5.9E-03	6.3E-03	2.9E-10	1.2E-09	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 3.40E-03	RME 1.74E-02	100%						
Summed Cancer Risk									MLE 6.46E-07	RME 3.09E-06	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-67. RISK FROM SOIL DERMAL CONTACT BY BASE PERSONNEL - CURRENT CONDITIONS BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Surface Soil (mg/kg) MLE	RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	RME	RME % of total ELCR
INORGANICS											
Antimony	1.2E-01	1.7E-01	5.7E-07	9.6E-06	1%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.4E+00	1.0E+01	5.5E-05	7.7E-04	74%	skin; keratosis, hyperpigmentation	3	[A]	1.0E-08	1.4E-07	42%
Beryllium	4.1E-01	5.3E-01	1.6E-07	2.4E-06	0%	no observed effects	100	[B2]	1.2E-09	1.8E-08	5%
Cadmium (food)	3.9E-01	8.5E-01	7.7E-07	1.9E-05	2%	kidney; proteinuria	10	- -			
Chromium (III)	3.0E+01	6.7E+01	5.9E-08	1.5E-06	0%	no observed effects	100	- -			
Copper	2.1E+01	3.2E+01	1.1E-06	2.0E-05	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.3E+01	7.0E+01				CNS, blood	- -	[B2]			
Mercury	1.2E-01	2.7E-01	7.6E-07	2.1E-05	2%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	2.3E+01	3.9E+01	2.2E-06	4.4E-05	4%	dec. body and organ weight	300	- -			
Selenium	1.1E-01	1.8E-01	4.4E-08	8.3E-07	0%	whole body; clinical selenosis	3	[D]			
Silver	1.7E+00	3.2E+00	6.8E-07	1.5E-05	1%	skin; argyria	3	[D]			
Thallium	2.4E-01	3.4E-01	5.9E-06	9.8E-05	10%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	1.0E+02	2.0E+02	6.5E-07	1.5E-05	1%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthylene	1.1E-01	1.1E-01	7.1E-08	8.3E-07	0%	- -	- -	[D]			
Anthracene	1.2E-01	1.2E-01	7.6E-09	8.8E-08	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	1.8E-01	2.0E-01	1.2E-07	1.5E-06	0%	- -	- -	[B2]	9.4E-10	1.2E-08	3%
Benzo(a)pyrene	1.9E-01	2.0E-01	1.2E-07	1.6E-06	0%	- -	- -	[B2]	9.6E-09	1.2E-07	36%
Benzo(b)fluoranthene	2.3E-01	3.4E-01	1.5E-07	2.6E-06	0%	- -	- -	[B2]	1.2E-09	2.0E-08	6%
Benzo(g,h,i)perylene	1.9E-01	2.0E-01	1.2E-07	1.5E-06	0%	- -	- -	[D]			
Benzo(k)fluoranthene	1.5E-01	1.5E-01	1.0E-07	1.2E-06	0%	- -	- -	[B2]	7.8E-10	9.1E-09	3%
Carbazole	1.1E-01	1.1E-01				- -	- -	[B2]	1.6E-11	1.8E-10	0%
Chrysene	2.0E-01	2.2E-01	1.3E-07	1.7E-06	0%	- -	- -	[B2]	1.0E-10	1.3E-09	0%
Ethylbenzene	5.8E-03	6.1E-03	1.1E-09	1.4E-08	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	2.2E-01	3.3E-01	1.1E-07	1.9E-06	0%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Indeno(1,2,3-cd)pyrene	2.0E-01	2.4E-01	1.3E-07	1.8E-06	0%	- -	- -	[B2]	1.0E-09	1.4E-08	4%
Phenanthrene	1.8E-01	2.2E-01	1.2E-07	1.7E-06	0%	- -	- -	[D]			
Pyrene	2.2E-01	3.3E-01	1.5E-07	2.5E-06	0%	kidney; red. weight, renal tubular pathology	3000	[D]			
Toluene	6.8E-03	8.9E-03	6.7E-10	1.0E-08	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	1000	[D]			
Xylenes	5.9E-03	6.3E-03	5.8E-11	7.2E-10	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 6.93E-05	RME 1.03E-03	100%						
Summed Cancer Risk									MLE 2.52E-08	RME 3.39E-07	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-68. RISK FROM SOIL INGESTION BY CONSTRUCTION WORKER - CURRENT CONDITIONS
BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Construction Zone Soil (mg/kg) MLE	EPC RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	HQ RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR RME	RME % of total ELCR
INORGANICS											
Antimony	1.2E-01	1.7E-01	5.7E-04	2.0E-03	1%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.4E+00	1.0E+01	5.5E-02	1.6E-01	76%	skin; keratosis, hyperpigmentation	3	[A]	8.3E-07	2.4E-06	80%
Beryllium	4.1E-01	5.3E-01	1.6E-04	4.9E-04	0%	no observed effects	100	[B2]	9.9E-08	3.0E-07	10%
Cadmium (food)	3.9E-01	8.5E-01	7.7E-04	4.0E-03	2%	kidney; proteinuria	10	- -			
Chromium (III)	3.0E+01	6.7E+01	5.9E-05	3.1E-04	0%	no observed effects	100	- -			
Copper	2.1E+01	3.2E+01	1.1E-03	4.1E-03	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.3E+01	7.0E+01				CNS, blood	- -	[B2]			
Mercury	1.2E-01	2.7E-01	7.6E-04	4.3E-03	2%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	2.3E+01	3.9E+01	2.2E-03	9.1E-03	4%	dec. body and organ weight	300	- -			
Selenium	1.1E-01	1.8E-01	4.4E-05	1.7E-04	0%	whole body; clinical selenosis	3	[D]			
Silver	1.7E+00	3.2E+00	6.8E-04	3.0E-03	1%	skin; argyria	3	[D]			
Thallium	2.4E-01	3.4E-01	5.9E-03	2.0E-02	10%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	1.0E+02	2.0E+02	6.5E-04	3.1E-03	1%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthylene	1.1E-01	1.1E-01	7.1E-06	1.7E-05	0%	- -	- -	[D]			
Anthracene	1.2E-01	1.2E-01	7.6E-07	1.8E-06	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	1.8E-01	2.0E-01	1.2E-05	3.1E-05	0%	- -	- -	[B2]	7.5E-09	1.9E-08	1%
Benzo(a)pyrene	1.9E-01	2.0E-01	1.2E-05	3.2E-05	0%	- -	- -	[B2]	7.7E-08	2.0E-07	7%
Benzo(b)fluoranthene	2.3E-01	3.4E-01	1.5E-05	5.3E-05	0%	- -	- -	[B2]	9.2E-09	3.3E-08	1%
Benzo(g,h,i)perylene	1.9E-01	2.0E-01	1.2E-05	3.2E-05	0%	- -	- -	[D]			
Benzo(k)fluoranthene	1.5E-01	1.5E-01	1.0E-05	2.4E-05	0%	- -	- -	[B2]	6.2E-09	1.5E-08	1%
Carbazole	1.1E-01	1.1E-01				- -	- -	[B2]	1.3E-10	3.0E-10	0%
Chrysene	2.0E-01	2.2E-01	1.3E-05	3.5E-05	0%	- -	- -	[B2]	8.0E-10	2.2E-09	0%
Ethylbenzene	5.8E-03	6.1E-03	1.1E-07	2.9E-07	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	2.2E-01	3.3E-01	1.1E-05	3.8E-05	0%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Indeno(1,2,3-cd)pyrene	2.0E-01	2.4E-01	1.3E-05	3.7E-05	0%	- -	- -	[B2]	8.3E-09	2.3E-08	1%
Phenanthrene	1.8E-01	2.2E-01	1.2E-05	3.5E-05	0%	- -	- -	[D]			
Pyrene	2.2E-01	3.3E-01	1.5E-05	5.1E-05	0%	kidney; red. weight, renal tubular pathology	3000	[D]			
Toluene	6.8E-03	8.9E-03	6.7E-08	2.1E-07	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	1000	[D]			
Xylenes	5.9E-03	6.3E-03	5.8E-09	1.5E-08	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 6.81E-02	RME 2.09E-01	100%						
Summed Cancer Risk									MLE 1.03E-06	RME 2.97E-06	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-69. RISK FROM SOIL DERMAL CONTACT BY CONSTRUCTION WORKER - CURRENT CONDITIONS BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Construction Zone Soil (mg/kg) MLE	Exposure Point Concentration in Construction Zone Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	1.2E-01	1.7E-01	2.9E-06	2.4E-05	1%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.4E+00	1.0E+01	2.8E-04	1.9E-03	74%	skin; keratosis, hyperpigmentation	3	[A]	4.1E-09	2.9E-08	42%
Beryllium	4.1E-01	5.3E-01	8.1E-07	6.0E-06	0%	no observed effects	100	[B2]	5.0E-10	3.7E-09	5%
Cadmium (food)	3.9E-01	8.5E-01	3.9E-06	4.8E-05	2%	kidney; proteinuria	10	- -			
Chromium (III)	3.0E+01	6.7E+01	2.9E-07	3.8E-06	0%	no observed effects	100	- -			
Copper	2.1E+01	3.2E+01	5.5E-06	4.9E-05	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.3E+01	7.0E+01				CNS, blood	- -	[B2]			
Mercury	1.2E-01	2.7E-01	3.8E-06	5.1E-05	2%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	2.3E+01	3.9E+01	1.1E-05	1.1E-04	4%	dec. body and organ weight	300	- -			
Selenium	1.1E-01	1.8E-01	2.2E-07	2.1E-06	0%	whole body; clinical selenosis	3	[D]			
Silver	1.7E+00	3.2E+00	3.4E-06	3.7E-05	1%	skin; argyria	3	[D]			
Thallium	2.4E-01	3.4E-01	3.0E-05	2.4E-04	10%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	1.0E+02	2.0E+02	3.3E-06	3.8E-05	1%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthylene	1.1E-01	1.1E-01	3.6E-07	2.1E-06	0%	- -	- -	[D]			
Anthracene	1.2E-01	1.2E-01	3.8E-08	2.2E-07	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	1.8E-01	2.0E-01	6.0E-07	3.7E-06	0%	- -	- -	[B2]	3.7E-10	2.3E-09	3%
Benzo(a)pyrene	1.9E-01	2.0E-01	6.1E-07	3.9E-06	0%	- -	- -	[B2]	3.8E-09	2.4E-08	36%
Benzo(b)fluoranthene	2.3E-01	3.4E-01	7.4E-07	6.5E-06	0%	- -	- -	[B2]	4.6E-10	4.0E-09	6%
Benzo(g,h,i)perylene	1.9E-01	2.0E-01	6.1E-07	3.8E-06	0%	- -	- -	[D]			
Benzo(k)fluoranthene	1.5E-01	1.5E-01	5.0E-07	2.9E-06	0%	- -	- -	[B2]	3.1E-10	1.8E-09	3%
Carbazole	1.1E-01	1.1E-01				- -	- -	[B2]	6.3E-12	3.6E-11	0%
Chrysene	2.0E-01	2.2E-01	6.4E-07	4.2E-06	0%	- -	- -	[B2]	4.0E-11	2.6E-10	0%
Ethylbenzene	5.8E-03	6.1E-03	5.7E-09	3.5E-08	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	2.2E-01	3.3E-01	5.5E-07	4.6E-06	0%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Indeno(1,2,3-cd)pyrene	2.0E-01	2.4E-01	6.6E-07	4.5E-06	0%	- -	- -	[B2]	4.1E-10	2.8E-09	4%
Phenanthrene	1.8E-01	2.2E-01	5.9E-07	4.2E-06	0%	- -	- -	[D]			
Pyrene	2.2E-01	3.3E-01	7.3E-07	6.2E-06	0%	kidney; red. weight, renal tubular pathology	3000	[D]			
Toluene	6.8E-03	8.9E-03	3.3E-09	2.5E-08	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	1000	[D]			
Xylenes	5.9E-03	6.3E-03	2.9E-10	1.8E-09	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 3.46E-04	RME 2.57E-03	100%						
Summed Cancer Risk									MLE 1.01E-08	RME 6.79E-08	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-70. RISK FROM SOIL INGESTION BY RESIDENT CHILD - FUTURE CONDITIONS BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Soil (mg/kg) MLE	Exposure Point Concentration in Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	1.2E-01	1.7E-01	3.0E-03	5.4E-03	1%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.4E+00	1.0E+01	2.8E-01	4.3E-01	76%	skin; keratosis, hyperpigmentation	3	[A]	1.3E-05	1.9E-05	80%
Beryllium	4.1E-01	5.3E-01	8.3E-04	1.3E-03	0%	no observed effects	100	[B2]	1.5E-06	2.5E-06	10%
Cadmium (food)	3.9E-01	8.5E-01	4.0E-03	1.1E-02	2%	kidney; proteinuria	10	- -			
Chromium (III)	3.0E+01	6.7E+01	3.0E-04	8.5E-04	0%	no observed effects	100	- -			
Copper	2.1E+01	3.2E+01	5.6E-03	1.1E-02	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.3E+01	7.0E+01				CNS, blood	- -	[B2]			
Mercury	1.2E-01	2.7E-01	3.9E-03	1.2E-02	2%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	2.3E+01	3.9E+01	1.1E-02	2.5E-02	4%	dec. body and organ weight	300	- -			
Selenium	1.1E-01	1.8E-01	2.2E-04	4.7E-04	0%	whole body; clinical selenosis	3	[D]			
Silver	1.7E+00	3.2E+00	3.5E-03	8.3E-03	1%	skin; argyria	3	[D]			
Thallium	2.4E-01	3.4E-01	3.0E-02	5.5E-02	10%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	1.0E+02	2.0E+02	3.4E-03	8.5E-03	1%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthylene	1.1E-01	1.1E-01	3.7E-05	4.7E-05	0%	- -	- -	[D]			
Anthracene	1.2E-01	1.2E-01	3.9E-06	4.9E-06	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	1.8E-01	2.0E-01	6.1E-05	8.4E-05	0%	- -	- -	[B2]	1.2E-07	1.6E-07	1%
Benzo(a)pyrene	1.9E-01	2.0E-01	6.3E-05	8.7E-05	0%	- -	- -	[B2]	1.2E-06	1.6E-06	7%
Benzo(b)fluoranthene	2.3E-01	3.4E-01	7.6E-05	1.5E-04	0%	- -	- -	[B2]	1.4E-07	2.7E-07	1%
Benzo(g,h,i)perylene	1.9E-01	2.0E-01	6.3E-05	8.6E-05	0%	- -	- -	[D]			
Benzo(k)fluoranthene	1.5E-01	1.5E-01	5.1E-05	6.5E-05	0%	- -	- -	[B2]	9.6E-08	1.2E-07	1%
Carbazole	1.1E-01	1.1E-01				- -	- -	[B2]	1.9E-09	2.5E-09	0%
Chrysene	2.0E-01	2.2E-01	6.6E-05	9.4E-05	0%	- -	- -	[B2]	1.2E-08	1.8E-08	0%
Ethylbenzene	5.8E-03	6.1E-03	5.8E-07	7.8E-07	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	2.2E-01	3.3E-01	5.6E-05	1.0E-04	0%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Indeno(1,2,3-cd)pyrene	2.0E-01	2.4E-01	6.8E-05	1.0E-04	0%	- -	- -	[B2]	1.3E-07	1.9E-07	1%
Phenanthrene	1.8E-01	2.2E-01	6.1E-05	9.6E-05	0%	- -	- -	[D]			
Pyrene	2.2E-01	3.3E-01	7.4E-05	1.4E-04	0%	kidney; red. weight, renal tubular pathology	3000	[D]			
Toluene	6.8E-03	8.9E-03	3.4E-07	5.7E-07	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	1000	[D]			
Xylenes	5.9E-03	6.3E-03	3.0E-08	4.0E-08	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 3.49E-01	RME 5.70E-01	100%						
Summed Cancer Risk									MLE 1.59E-05	RME 2.43E-05	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-71. RISK FROM SOIL INHALATION BY RESIDENT CHILD - FUTURE CONDITIONS
BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Soil (mg/kg) MLE	Exposure Point Concentration in Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	1.2E-01	1.7E-01				whole body, blood; inc. mortality	--	--			
Arsenic	8.4E+00	1.0E+01				skin; keratosis, hyperpigmentation	--	[A]	7.8E-09	1.2E-08	98%
Beryllium	4.1E-01	5.3E-01				no observed effects	--	[B2]	6.4E-11	1.0E-10	1%
Cadmium (food)	3.9E-01	8.5E-01				kidney; proteinuria	--	--	4.5E-11	1.2E-10	1%
Chromium (III)	3.0E+01	6.7E+01				no observed effects	--	--			
Copper	2.1E+01	3.2E+01				Gastrointestinal system; irritation	--	[D]			
Lead	3.3E+01	7.0E+01				CNS, blood	--	[B2]			
Mercury	1.2E-01	2.7E-01	3.0E-07	8.8E-07	100%	oral-CNS; neurotoxicity. inhal.-kidney effects	30	[D]			
Nickel	2.3E+01	3.9E+01				dec. body and organ weight	--	--			
Selenium	1.1E-01	1.8E-01				whole body; clinical selenosis	--	[D]			
Silver	1.7E+00	3.2E+00				skin; argyria	--	[D]			
Thallium	2.4E-01	3.4E-01				liver, blood; inc. sgot and serum LDH	--	[D]			
Zinc	1.0E+02	2.0E+02				blood; anemia	--	[D]			
ORGANICS											
Acenaphthylene	1.1E-01	1.1E-01				--	--	[D]			
Anthracene	1.2E-01	1.2E-01				no observed effects	--	[D]			
Benzo(a)anthracene	1.8E-01	2.0E-01				--	--	[B2]			
Benzo(a)pyrene	1.9E-01	2.0E-01				--	--	[B2]			
Benzo(b)fluoranthene	2.3E-01	3.4E-01				--	--	[B2]			
Benzo(g,h,i)perylene	1.9E-01	2.0E-01				--	--	[D]			
Benzo(k)fluoranthene	1.5E-01	1.5E-01				--	--	[B2]			
Carbazole	1.1E-01	1.1E-01				--	--	[B2]			
Chrysene	2.0E-01	2.2E-01				--	--	[B2]			
Ethylbenzene	5.8E-03	6.1E-03	4.4E-12	5.9E-12	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	300	[D]			
Fluoranthene	2.2E-01	3.3E-01				kidney, liver, blood; inc. weight, hematological changes	--	[D]			
Indeno(1,2,3-cd)pyrene	2.0E-01	2.4E-01				--	--	[B2]			
Phenanthrene	1.8E-01	2.2E-01				--	--	[D]			
Pyrene	2.2E-01	3.3E-01				kidney; red. weight, renal tubular pathology	--	[D]			
Toluene	6.8E-03	8.9E-03	1.3E-11	2.2E-11	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	300	[D]			
Xylenes	5.9E-03	6.3E-03				CNS hyperactivity; dec. body weight	--	[D]			

Summed	MLE	RME	
Hazard Quotient	2.96E-07	8.75E-07	100%

Summed	MLE	RME	
Cancer Risk	7.95E-09	1.22E-08	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-72. RISK FROM SOIL DERMAL CONTACT BY RESIDENT CHILD - FUTURE CONDITIONS BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Soil (mg/kg) MLE	Exposure Point Concentration in Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	1.2E-01	1.7E-01	5.2E-06	5.4E-05	1%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.4E+00	1.0E+01	4.9E-04	4.3E-03	74%	skin; keratosis, hyperpigmentation	3	[A]	2.2E-08	1.9E-07	42%
Beryllium	4.1E-01	5.3E-01	1.5E-06	1.3E-05	0%	no observed effects	100	[B2]	2.7E-09	2.5E-08	5%
Cadmium (food)	3.9E-01	8.5E-01	6.9E-06	1.1E-04	2%	kidney; proteinuria	10	- -			
Chromium (III)	3.0E+01	6.7E+01	5.3E-07	8.6E-06	0%	no observed effects	100	- -			
Copper	2.1E+01	3.2E+01	9.8E-06	1.1E-04	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.3E+01	7.0E+01				CNS, blood	- -	[B2]			
Mercury	1.2E-01	2.7E-01	6.9E-06	1.2E-04	2%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	2.3E+01	3.9E+01	2.0E-05	2.5E-04	4%	dec. body and organ weight	300	- -			
Selenium	1.1E-01	1.8E-01	3.9E-07	4.7E-06	0%	whole body; clinical selenosis	3	[D]			
Silver	1.7E+00	3.2E+00	6.1E-06	8.3E-05	1%	skin; argyria	3	[D]			
Thallium	2.4E-01	3.4E-01	5.3E-05	5.5E-04	10%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	1.0E+02	2.0E+02	5.9E-06	8.5E-05	1%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthylene	1.1E-01	1.1E-01	6.4E-07	4.7E-06	0%	- -	- -	[D]			
Anthracene	1.2E-01	1.2E-01	6.8E-08	5.0E-07	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	1.8E-01	2.0E-01	1.1E-06	8.4E-06	0%	- -	- -	[B2]	2.0E-09	1.6E-08	3%
Benzo(a)pyrene	1.9E-01	2.0E-01	1.1E-06	8.8E-06	0%	- -	- -	[B2]	2.1E-08	1.6E-07	36%
Benzo(b)fluoranthene	2.3E-01	3.4E-01	1.3E-06	1.5E-05	0%	- -	- -	[B2]	2.5E-09	2.7E-08	6%
Benzo(g,h,i)perylene	1.9E-01	2.0E-01	1.1E-06	8.6E-06	0%	- -	- -	[D]			
Benzo(k)fluoranthene	1.5E-01	1.5E-01	9.0E-07	6.6E-06	0%	- -	- -	[B2]	1.7E-09	1.2E-08	3%
Carbazole	1.1E-01	1.1E-01				- -	- -	[B2]	3.4E-11	2.5E-10	0%
Chrysene	2.0E-01	2.2E-01	1.1E-06	9.5E-06	0%	- -	- -	[B2]	2.2E-10	1.8E-09	0%
Ethylbenzene	5.8E-03	6.1E-03	1.0E-08	7.8E-08	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	2.2E-01	3.3E-01	9.8E-07	1.1E-05	0%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Indeno(1,2,3-cd)pyrene	2.0E-01	2.4E-01	1.2E-06	1.0E-05	0%	- -	- -	[B2]	2.2E-09	1.9E-08	4%
Phenanthrene	1.8E-01	2.2E-01	1.1E-06	9.6E-06	0%	- -	- -	[D]			
Pyrene	2.2E-01	3.3E-01	1.3E-06	1.4E-05	0%	kidney; red. weight, renal tubular pathology	3000	[D]			
Toluene	6.8E-03	8.9E-03	6.0E-09	5.7E-08	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	1000	[D]			
Xylenes	5.9E-03	6.3E-03	5.2E-10	4.0E-09	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 6.22E-04	RME 5.82E-03	100%						
Summed Cancer Risk									MLE 5.43E-08	RME 4.61E-07	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

**TABLE H-73. RISK FROM VAPOR INHALATION BY RESIDENT CHILD - FUTURE CONDITIONS
BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO**

Chemical	Exposure Point Concentration in Soil (mg/kg) MLE	Exposure Point Concentration in Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR RME	RME % of total ELCR
INORGANICS											
Antimony	1.2E-01	1.7E-01				whole body, blood; inc. mortality	--	--			
Arsenic	8.4E+00	1.0E+01				skin; keratosis, hyperpigmentation	--	[A]			
Beryllium	4.1E-01	5.3E-01				no observed effects	--	[B2]			
Cadmium (food)	3.9E-01	8.5E-01				kidney; proteinuria	--	--			
Chromium (III)	3.0E+01	6.7E+01				no observed effects	--	--			
Copper	2.1E+01	3.2E+01				Gastrointestinal system; irritation	--	[D]			
Lead	3.3E+01	7.0E+01				CNS, blood	--	[B2]			
Mercury	1.2E-01	2.7E-01				oral-CNS; neurotoxicity. inhal.-kidney effects	30	[D]			
Nickel	2.3E+01	3.9E+01				dec. body and organ weight	--	--			
Selenium	1.1E-01	1.8E-01				whole body; clinical selenosis	--	[D]			
Silver	1.7E+00	3.2E+00				skin; argyria	--	[D]			
Thallium	2.4E-01	3.4E-01				liver, blood; inc. sgot and serum LDH	--	[D]			
Zinc	1.0E+02	2.0E+02				blood; anemia	--	[D]			
ORGANICS											
Acenaphthylene	1.1E-01	1.1E-01				--	--	[D]			
Anthracene	1.2E-01	1.2E-01				no observed effects	--	[D]			
Benzo(a)anthracene	1.8E-01	2.0E-01				--	--	[B2]			
Benzo(a)pyrene	1.9E-01	2.0E-01				--	--	[B2]			
Benzo(b)fluoranthene	2.3E-01	3.4E-01				--	--	[B2]			
Benzo(g,h,i)perylene	1.9E-01	2.0E-01				--	--	[D]			
Benzo(k)fluoranthene	1.5E-01	1.5E-01				--	--	[B2]			
Carbazole	1.1E-01	1.1E-01				--	--	[B2]			
Chrysene	2.0E-01	2.2E-01				--	--	[B2]			
Ethylbenzene	5.8E-03	6.1E-03	5.5E-06	7.4E-06	22%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	300	[D]			
Fluoranthene	2.2E-01	3.3E-01				kidney, liver, blood; inc. weight, hematological changes	--	[D]			
Indeno(1,2,3-cd)pyrene	2.0E-01	2.4E-01				--	--	[B2]			
Phenanthrene	1.8E-01	2.2E-01				--	--	[D]			
Pyrene	2.2E-01	3.3E-01				kidney; red. weight, renal tubular pathology	--	[D]			
Toluene	6.8E-03	8.9E-03	1.6E-05	2.7E-05	78%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	300	[D]			
Xylenes	5.9E-03	6.3E-03				CNS hyperactivity; dec. body weight	--	[D]			

Summed Hazard Quotient	MLE	RME	
	2.17E-05	3.43E-05	100%

Summed Cancer Risk	MLE	RME
	--	--

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-74. RISK FROM SOIL INGESTION BY RESIDENT ADULT - FUTURE CONDITIONS
BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Soil (mg/kg) MLE	Exposure Point Concentration in Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	1.2E-01	1.7E-01	3.2E-04	5.8E-04	1%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.4E+00	1.0E+01	3.0E-02	4.6E-02	76%	skin; keratosis, hyperpigmentation	3	[A]	2.0E-06	8.3E-06	80%
Beryllium	4.1E-01	5.3E-01	8.9E-05	1.4E-04	0%	no observed effects	100	[B2]	2.5E-07	1.1E-06	10%
Cadmium (food)	3.9E-01	8.5E-01	4.2E-04	1.2E-03	2%	kidney; proteinuria	10	- -			
Chromium (III)	3.0E+01	6.7E+01	3.2E-05	9.2E-05	0%	no observed effects	100	- -			
Copper	2.1E+01	3.2E+01	6.0E-04	1.2E-03	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.3E+01	7.0E+01				CNS, blood	- -	[B2]			
Mercury	1.2E-01	2.7E-01	4.2E-04	1.2E-03	2%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	2.3E+01	3.9E+01	1.2E-03	2.6E-03	4%	dec. body and organ weight	300	- -			
Selenium	1.1E-01	1.8E-01	2.4E-05	5.0E-05	0%	whole body; clinical selenosis	3	[D]			
Silver	1.7E+00	3.2E+00	3.7E-04	8.8E-04	1%	skin; argyria	3	[D]			
Thallium	2.4E-01	3.4E-01	3.2E-03	5.9E-03	10%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	1.0E+02	2.0E+02	3.6E-04	9.1E-04	1%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthylene	1.1E-01	1.1E-01	3.9E-06	5.0E-06	0%	- -	- -	[D]			
Anthracene	1.2E-01	1.2E-01	4.2E-07	5.3E-07	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	1.8E-01	2.0E-01	6.6E-06	9.0E-06	0%	- -	- -	[B2]	1.9E-08	6.7E-08	1%
Benzo(a)pyrene	1.9E-01	2.0E-01	6.8E-06	9.4E-06	0%	- -	- -	[B2]	1.9E-07	7.0E-07	7%
Benzo(b)fluoranthene	2.3E-01	3.4E-01	8.1E-06	1.6E-05	0%	- -	- -	[B2]	2.3E-08	1.2E-07	1%
Benzo(g,h,i)perylene	1.9E-01	2.0E-01	6.7E-06	9.2E-06	0%	- -	- -	[D]			
Benzo(k)fluoranthene	1.5E-01	1.5E-01	5.5E-06	7.0E-06	0%	- -	- -	[B2]	1.5E-08	5.2E-08	1%
Carbazole	1.1E-01	1.1E-01				- -	- -	[B2]	3.1E-10	1.1E-09	0%
Chrysene	2.0E-01	2.2E-01	7.0E-06	1.0E-05	0%	- -	- -	[B2]	2.0E-09	7.6E-09	0%
Ethylbenzene	5.8E-03	6.1E-03	6.2E-08	8.4E-08	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	2.2E-01	3.3E-01	6.0E-06	1.1E-05	0%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Indeno(1,2,3-cd)pyrene	2.0E-01	2.4E-01	7.3E-06	1.1E-05	0%	- -	- -	[B2]	2.0E-08	8.1E-08	1%
Phenanthrene	1.8E-01	2.2E-01	6.5E-06	1.0E-05	0%	- -	- -	[D]			
Pyrene	2.2E-01	3.3E-01	8.0E-06	1.5E-05	0%	kidney; red. weight, renal tubular pathology	3000	[D]			
Toluene	6.8E-03	8.9E-03	3.7E-08	6.1E-08	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	1000	[D]			
Xylenes	5.9E-03	6.3E-03	3.2E-09	4.3E-09	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 3.74E-02	RME 6.11E-02	100%						
Summed Cancer Risk									MLE 2.56E-06	RME 1.04E-05	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-75. RISK FROM SOIL INHALATION BY RESIDENT ADULT - FUTURE CONDITIONS
BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Soil (mg/kg)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	1.2E-01	1.7E-01				whole body, blood; inc. mortality	--	--			
Arsenic	8.4E+00	1.0E+01				skin; keratosis, hyperpigmentation	--	[A]	2.5E-09	1.3E-08	98%
Beryllium	4.1E-01	5.3E-01				no observed effects	--	[B2]	2.1E-11	1.1E-10	1%
Cadmium (food)	3.9E-01	8.5E-01				kidney; proteinuria	--	--	1.4E-11	1.3E-10	1%
Chromium (III)	3.0E+01	6.7E+01				no observed effects	--	--			
Copper	2.1E+01	3.2E+01				Gastrointestinal system; irritation	--	[D]			
Lead	3.3E+01	7.0E+01				CNS, blood	--	[B2]			
Mercury	1.2E-01	2.7E-01	6.4E-08	1.9E-07	100%	oral-CNS; neurotoxicity. inhal.-kidney effects	30	[D]			
Nickel	2.3E+01	3.9E+01				dec. body and organ weight	--	--			
Selenium	1.1E-01	1.8E-01				whole body; clinical selenosis	--	[D]			
Silver	1.7E+00	3.2E+00				skin; argyria	--	[D]			
Thallium	2.4E-01	3.4E-01				liver, blood; inc. sgot and serum LDH	--	[D]			
Zinc	1.0E+02	2.0E+02				blood; anemia	--	[D]			
ORGANICS											
Acenaphthylene	1.1E-01	1.1E-01				--	--	[D]			
Anthracene	1.2E-01	1.2E-01				no observed effects	--	[D]			
Benzo(a)anthracene	1.8E-01	2.0E-01				--	--	[B2]			
Benzo(a)pyrene	1.9E-01	2.0E-01				--	--	[B2]			
Benzo(b)fluoranthene	2.3E-01	3.4E-01				--	--	[B2]			
Benzo(g,h,i)perylene	1.9E-01	2.0E-01				--	--	[D]			
Benzo(k)fluoranthene	1.5E-01	1.5E-01				--	--	[B2]			
Carbazole	1.1E-01	1.1E-01				--	--	[B2]			
Chrysene	2.0E-01	2.2E-01				--	--	[B2]			
Ethylbenzene	5.8E-03	6.1E-03	9.4E-13	1.3E-12	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	300	[D]			
Fluoranthene	2.2E-01	3.3E-01				kidney, liver, blood; inc. weight, hematological changes	--	[D]			
Indeno(1,2,3-cd)pyrene	2.0E-01	2.4E-01				--	--	[B2]			
Phenanthrene	1.8E-01	2.2E-01				--	--	[D]			
Pyrene	2.2E-01	3.3E-01				kidney; red. weight, renal tubular pathology	--	[D]			
Toluene	6.8E-03	8.9E-03	2.8E-12	4.6E-12	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	300	[D]			
Xylenes	5.9E-03	6.3E-03				CNS hyperactivity; dec. body weight	--	[D]			
Summed Hazard Quotient			MLE 6.35E-08	RME 1.88E-07	100%						
Summed Cancer Risk									MLE 2.56E-09	RME 1.31E-08	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-76. RISK FROM SOIL DERMAL CONTACT BY RESIDENT ADULT - FUTURE CONDITIONS BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Soil (mg/kg) MLE	Exposure Point Concentration in Soil (mg/kg) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	1.2E-01	1.7E-01	3.2E-06	3.4E-05	1%	whole body, blood; inc. mortality	1000	- -			
Arsenic	8.4E+00	1.0E+01	3.0E-04	2.7E-03	74%	skin; keratosis, hyperpigmentation	3	[A]	2.0E-08	6.0E-07	42%
Beryllium	4.1E-01	5.3E-01	8.9E-07	8.3E-06	0%	no observed effects	100	[B2]	2.5E-09	7.7E-08	5%
Cadmium (food)	3.9E-01	8.5E-01	4.2E-06	6.7E-05	2%	kidney; proteinuria	10	- -			
Chromium (III)	3.0E+01	6.7E+01	3.2E-07	5.3E-06	0%	no observed effects	100	- -			
Copper	2.1E+01	3.2E+01	6.0E-06	6.9E-05	2%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.3E+01	7.0E+01				CNS, blood	- -	[B2]			
Mercury	1.2E-01	2.7E-01	4.2E-06	7.2E-05	2%	oral-CNS; neurotoxicity. inhal.-kidney effects	1000	[D]			
Nickel	2.3E+01	3.9E+01	1.2E-05	1.5E-04	4%	dec. body and organ weight	300	- -			
Selenium	1.1E-01	1.8E-01	2.4E-07	2.9E-06	0%	whole body; clinical selenosis	3	[D]			
Silver	1.7E+00	3.2E+00	3.7E-06	5.1E-05	1%	skin; argyria	3	[D]			
Thallium	2.4E-01	3.4E-01	3.2E-05	3.4E-04	10%	liver, blood; inc. sgot and serum LDH	3000	[D]			
Zinc	1.0E+02	2.0E+02	3.6E-06	5.3E-05	1%	blood; anemia	3	[D]			
ORGANICS											
Acenaphthylene	1.1E-01	1.1E-01	3.9E-07	2.9E-06	0%	- -	- -	[D]			
Anthracene	1.2E-01	1.2E-01	4.2E-08	3.1E-07	0%	no observed effects	3000	[D]			
Benzo(a)anthracene	1.8E-01	2.0E-01	6.6E-07	5.2E-06	0%	- -	- -	[B2]	1.9E-09	4.9E-08	3%
Benzo(a)pyrene	1.9E-01	2.0E-01	6.8E-07	5.4E-06	0%	- -	- -	[B2]	1.9E-08	5.1E-07	36%
Benzo(b)fluoranthene	2.3E-01	3.4E-01	8.1E-07	9.0E-06	0%	- -	- -	[B2]	2.3E-09	8.5E-08	6%
Benzo(g,h,i)perylene	1.9E-01	2.0E-01	6.7E-07	5.3E-06	0%	- -	- -	[D]			
Benzo(k)fluoranthene	1.5E-01	1.5E-01	5.5E-07	4.1E-06	0%	- -	- -	[B2]	1.5E-09	3.8E-08	3%
Carbazole	1.1E-01	1.1E-01				- -	- -	[B2]	3.1E-11	7.6E-10	0%
Chrysene	2.0E-01	2.2E-01	7.0E-07	5.8E-06	0%	- -	- -	[B2]	2.0E-10	5.5E-09	0%
Ethylbenzene	5.8E-03	6.1E-03	6.2E-09	4.8E-08	0%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	1000	[D]			
Fluoranthene	2.2E-01	3.3E-01	6.0E-07	6.5E-06	0%	kidney, liver, blood; inc. weight, hematological changes	3000	[D]			
Indeno(1,2,3-cd)pyrene	2.0E-01	2.4E-01	7.3E-07	6.3E-06	0%	- -	- -	[B2]	2.0E-09	5.9E-08	4%
Phenanthrene	1.8E-01	2.2E-01	6.5E-07	5.9E-06	0%	- -	- -	[D]			
Pyrene	2.2E-01	3.3E-01	8.0E-07	8.7E-06	0%	kidney; red. weight, renal tubular pathology	3000	[D]			
Toluene	6.8E-03	8.9E-03	3.7E-09	3.5E-08	0%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	1000	[D]			
Xylenes	5.9E-03	6.3E-03	3.2E-10	2.5E-09	0%	CNS hyperactivity; dec. body weight	100	[D]			
Summed Hazard Quotient			MLE 3.81E-04	RME 3.60E-03	100%						
Summed Cancer Risk									MLE 4.99E-08	RME 1.43E-06	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-77. RISK FROM VAPOR INHALATION BY RESIDENT ADULT - FUTURE CONDITIONS BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Soil (mg/kg)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (inhalation)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	1.2E-01	1.7E-01				whole body, blood; inc. mortality	--	--			
Arsenic	8.4E+00	1.0E+01				skin; keratosis, hyperpigmentation	--	[A]			
Beryllium	4.1E-01	5.3E-01				no observed effects	--	[B2]			
Cadmium (food)	3.9E-01	8.5E-01				kidney; proteinuria	--	--			
Chromium (III)	3.0E+01	6.7E+01				no observed effects	--	--			
Copper	2.1E+01	3.2E+01				Gastrointestinal system; irritation	--	[D]			
Lead	3.3E+01	7.0E+01				CNS, blood	--	[B2]			
Mercury	1.2E-01	2.7E-01				oral-CNS; neurotoxicity. inhal.-kidney effects	30	[D]			
Nickel	2.3E+01	3.9E+01				dec. body and organ weight	--	--			
Selenium	1.1E-01	1.8E-01				whole body; clinical selenosis	--	[D]			
Silver	1.7E+00	3.2E+00				skin; argyria	--	[D]			
Thallium	2.4E-01	3.4E-01				liver, blood; inc. sgot and serum LDH	--	[D]			
Zinc	1.0E+02	2.0E+02				blood; anemia	--	[D]			
ORGANICS											
Acenaphthylene	1.1E-01	1.1E-01				--	--	[D]			
Anthracene	1.2E-01	1.2E-01				no observed effects	--	[D]			
Benzo(a)anthracene	1.8E-01	2.0E-01				--	--	[B2]			
Benzo(a)pyrene	1.9E-01	2.0E-01				--	--	[B2]			
Benzo(b)fluoranthene	2.3E-01	3.4E-01				--	--	[B2]			
Benzo(g,h,i)perylene	1.9E-01	2.0E-01				--	--	[D]			
Benzo(k)fluoranthene	1.5E-01	1.5E-01				--	--	[B2]			
Carbazole	1.1E-01	1.1E-01				--	--	[B2]			
Chrysene	2.0E-01	2.2E-01				--	--	[B2]			
Ethylbenzene	5.8E-03	6.1E-03	1.2E-06	1.6E-06	22%	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity	300	[D]			
Fluoranthene	2.2E-01	3.3E-01				kidney, liver, blood; inc. weight, hematological changes	--	[D]			
Indeno(1,2,3-cd)pyrene	2.0E-01	2.4E-01				--	--	[B2]			
Phenanthrene	1.8E-01	2.2E-01				--	--	[D]			
Pyrene	2.2E-01	3.3E-01				kidney; red. weight, renal tubular pathology	--	[D]			
Toluene	6.8E-03	8.9E-03	3.5E-06	5.8E-06	78%	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects	300	[D]			
Xylenes	5.9E-03	6.3E-03				CNS hyperactivity; dec. body weight	--	[D]			
Summed Hazard Quotient			MLE 4.65E-06	RME 7.35E-06	100%						
Summed Cancer Risk									MLE --	RME --	

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-78. RISK FROM GROUNDWATER INGESTION BY RESIDENT CHILD - FUTURE CONDITIONS BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l) MLE	Exposure Point Concentration in Groundwater (mg/l) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	1.2E-03	1.5E-03	1.5E-01	2.4E-01	6%	whole body, blood; inc. mortality	1000	- -			
Arsenic	6.8E-03	1.2E-02	1.1E+00	2.5E+00	69%	skin; keratosis, hyperpigmentation	3	[A]	5.1E-05	1.1E-04	63%
Beryllium	1.5E-03	2.8E-03	1.5E-02	3.6E-02	1%	no observed effects	100	[B2]	2.8E-05	6.6E-05	37%
Chromium (III)	5.1E-02	9.5E-02	2.5E-03	6.1E-03	0%	no observed effects	100	- -			
Copper	6.8E-02	1.3E-01	9.2E-02	2.3E-01	6%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.2E-02	6.5E-02				CNS, blood	- -	[B2]			
Nickel	7.8E-02	1.6E-01	2.0E-01	5.0E-01	13%	dec. body and organ weight	300	- -			
Silver	2.2E-03	2.9E-03	2.2E-02	3.7E-02	1%	skin; argyria	3	[D]			
Zinc	2.7E-01	5.2E-01	4.5E-02	1.1E-01	3%	blood; anemia	3	[D]			
ORGANICS											
1,2-Dichloroethylene	3.0E-04	4.0E-04	1.7E-03	2.8E-03	0%	liver; hepatic lesions	1000	- -			
Trichloroethylene	3.0E-04	5.0E-04				- -	- -	- -			
Summed Hazard Quotient			MLE 1.66E+00	RME 3.69E+00	100%						
Summed Cancer Risk									MLE 7.90E-05	RME 1.80E-04	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-79. RISK FROM FILTERED GROUNDWATER INGESTION BY RESIDENT CHILD - FUTURE CONDITIONS
BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l) MLE	RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	RME	RME % of total ELCR
INORGANICS											
Antimony (d)	1.4E-03	1.9E-03	1.8E-01	3.0E-01	100%	whole body, blood; inc. mortality	1000	- -			
Lead (d)	1.9E-03	5.7E-03				CNS, blood	- -	[B2]			

Summed Hazard Quotient	MLE	RME	
	1.76E-01	3.04E-01	100%

Summed Cancer Risk	MLE	RME
	--	--

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-80. RISK FROM GROUNDWATER INHALATION BY RESIDENT CHILD - FUTURE CONDITIONS BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	1.2E-03	1.5E-03				whole body, blood; inc. mortality	--	--			
Arsenic	6.8E-03	1.2E-02				skin; keratosis, hyperpigmentation	--	[A]			
Beryllium	1.5E-03	2.8E-03				no observed effects	--	[B2]			
Chromium (III)	5.1E-02	9.5E-02				no observed effects	--	--			
Copper	6.8E-02	1.3E-01				Gastrointestinal system; irritation	--	[D]			
Lead	3.2E-02	6.5E-02				CNS, blood	--	[B2]			
Nickel	7.8E-02	1.6E-01				dec. body and organ weight	--	--			
Silver	2.2E-03	2.9E-03				skin; argyria	--	[D]			
Zinc	2.7E-01	5.2E-01				blood; anemia	--	[D]			

	MLE	RME
Summed Hazard Quotient	--	--

	MLE	RME
Summed Cancer Risk	--	--

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-81. RISK FROM FILTERED GROUNDWATER INHALATION BY RESIDENT CHILD - FUTURE CONDITIONS
BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l) MLE	Exposure Point Concentration in Groundwater (mg/l) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony (d)	1.4E-03	1.9E-03				whole body, blood; inc. mortality	- -	- -			
Lead (d)	1.9E-03	5.7E-03				CNS, blood	- -	[B2]			

Summed Hazard Quotient	MLE	RME
	--	--

Summed Cancer Risk	MLE	RME
	--	--

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-82. RISK FROM GROUNDWATER DERMAL CONTACT BY RESIDENT CHILD - FUTURE CONDITIONS BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l) MLE	Exposure Point Concentration in Groundwater (mg/l) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR RME	RME % of total ELCR
INORGANICS											
Antimony	1.2E-03	1.5E-03	1.2E-04	3.2E-04	7%	whole body, blood; inc. mortality	1000	- -			
Arsenic	6.8E-03	1.2E-02	9.3E-04	3.4E-03	78%	skin; keratosis, hyperpigmentation	3	[A]	4.2E-08	1.5E-07	63%
Beryllium	1.5E-03	2.8E-03	1.2E-05	4.8E-05	1%	no observed effects	100	[B2]	2.3E-08	8.8E-08	37%
Chromium (III)	5.1E-02	9.5E-02	4.1E-06	1.6E-05	0%	no observed effects	100	- -			
Copper	6.8E-02	1.3E-01	7.5E-05	3.1E-04	7%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.2E-02	6.5E-02				CNS, blood	- -	[B2]			
Nickel	7.8E-02	1.6E-01	1.6E-05	6.6E-05	2%	dec. body and organ weight	300	- -			
Silver	2.2E-03	2.9E-03	1.8E-05	4.9E-05	1%	skin; argyria	3	[D]			
Zinc	2.7E-01	5.2E-01	2.2E-05	8.8E-05	2%	blood; anemia	3	[D]			
ORGANICS											
1,2-Dichloroethylene	3.0E-04	4.0E-04	2.2E-05	6.1E-05	1%	liver; hepatic lesions	1000	- -			
Trichloroethylene	3.0E-04	5.0E-04				- -	- -	- -			
Summed Hazard Quotient			MLE 1.22E-03	RME 4.33E-03	100%						
Summed Cancer Risk									MLE 6.45E-08	RME 2.40E-07	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-83. RISK FROM FILTERED GROUNDWATER DERMAL CONTACT BY RESIDENT CHILD - FUTURE CONDITIONS
BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony (d)	1.4E-03	1.9E-03	1.4E-04	4.0E-04	100%	whole body, blood; inc. mortality	1000	- -			
Lead (d)	1.9E-03	5.7E-03				CNS, blood	- -	[B2]			
Summed Hazard Quotient			MLE 1.44E-04	RME 4.05E-04	100%						
Summed Cancer Risk									MLE --	RME --	

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-84. RISK FROM GROUNDWATER INGESTION BY RESIDENT ADULT - FUTURE CONDITIONS BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	1.2E-03	1.5E-03	4.5E-02	1.0E-01	6%	whole body, blood; inc. mortality	1000	- -			
Arsenic	6.8E-03	1.2E-02	3.4E-01	1.1E+00	69%	skin; keratosis, hyperpigmentation	3	[A]	2.3E-05	2.4E-04	63%
Beryllium	1.5E-03	2.8E-03	4.5E-03	1.5E-02	1%	no observed effects	100	[B2]	1.2E-05	1.4E-04	37%
Chromium (III)	5.1E-02	9.5E-02	7.6E-04	2.6E-03	0%	no observed effects	100	- -			
Copper	6.8E-02	1.3E-01	2.8E-02	9.8E-02	6%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.2E-02	6.5E-02				CNS, blood	- -	[B2]			
Nickel	7.8E-02	1.6E-01	5.9E-02	2.1E-01	13%	dec. body and organ weight	300	- -			
Silver	2.2E-03	2.9E-03	6.6E-03	1.6E-02	1%	skin; argyria	3	[D]			
Zinc	2.7E-01	5.2E-01	1.4E-02	4.7E-02	3%	blood; anemia	3	[D]			
ORGANICS											
1,2-Dichloroethylene	3.0E-04	4.0E-04	5.0E-04	1.2E-03	0%	liver; hepatic lesions	1000	- -			
Trichloroethylene	3.0E-04	5.0E-04			0%	- -	- -	- -			
Summed Hazard Quotient			MLE 4.99E-01	RME 1.58E+00	100%						
Summed Cancer Risk									MLE 3.56E-05	RME 3.86E-04	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-85. RISK FROM FILTERED GROUNDWATER INGESTION BY RESIDENT ADULT - FUTURE CONDITIONS
BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)					Carcinogenic Effects:			
			Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony (d)	1.4E-03	1.9E-03	5.3E-02	1.3E-01	100%	whole body, blood; inc. mortality	1000	- -			
Lead (d)	1.9E-03	5.7E-03				CNS, blood	- -	[B2]			

Summed Hazard Quotient	MLE	RME	
	5.27E-02	1.30E-01	100%

Summed Cancer Risk	MLE	RME
	--	--

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-86. RISK FROM GROUNDWATER INHALATION BY RESIDENT ADULT - FUTURE CONDITIONS
BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l) MLE	Exposure Point Concentration in Groundwater (mg/l) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	ELCR (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony	1.2E-03	1.5E-03				whole body, blood; inc. mortality	--	--			
Arsenic	6.8E-03	1.2E-02				skin; keratosis, hyperpigmentation	--	[A]			
Beryllium	1.5E-03	2.8E-03				no observed effects	--	[B2]			
Chromium (III)	5.1E-02	9.5E-02				no observed effects	--	--			
Copper	6.8E-02	1.3E-01				Gastrointestinal system; irritation	--	[D]			
Lead	3.2E-02	6.5E-02				CNS, blood	--	[B2]			
Nickel	7.8E-02	1.6E-01				dec. body and organ weight	--	--			
Silver	2.2E-03	2.9E-03				skin; argyria	--	[D]			
Zinc	2.7E-01	5.2E-01				blood; anemia	--	[D]			

Summed Hazard Quotient	MLE	RME
	--	--

Summed Cancer Risk	MLE	RME
	--	--

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-87. RISK FROM FILTERED GROUNDWATER INHALATION BY RESIDENT ADULT - FUTURE CONDITIONS
BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (inhalation)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony (d)	1.4E-03	1.9E-03				whole body, blood; inc. mortality	--	--			
Lead (d)	1.9E-03	5.7E-03				CNS, blood	--	[B2]			

Summed Hazard Quotient	MLE	RME
	--	--

Summed Cancer Risk	MLE	RME
	--	--

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-88. RISK FROM GROUNDWATER DERMAL CONTACT BY RESIDENT ADULT - FUTURE CONDITIONS BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l)		Noncarcinogenic Effects: Hazard Quotient (Intake/RfD)		RME % of total HQ	Target Organ System	UF (oral)	Carcinogenic Effects: WOE	Excess Lifetime Cancer Risk (ELCR) (Intake x q1)		RME % of total ELCR
	MLE	RME	MLE	RME					MLE	RME	
INORGANICS											
Antimony	1.2E-03	1.5E-03	7.5E-05	1.7E-04	7%	whole body, blood; inc. mortality	1000	- -			
Arsenic	6.8E-03	1.2E-02	5.7E-04	1.8E-03	78%	skin; keratosis, hyperpigmentation	3	[A]	3.8E-08	4.1E-07	63%
Beryllium	1.5E-03	2.8E-03	7.5E-06	2.6E-05	1%	no observed effects	100	[B2]	2.1E-08	2.4E-07	37%
Chromium (III)	5.1E-02	9.5E-02	2.5E-06	8.7E-06	0%	no observed effects	100	- -			
Copper	6.8E-02	1.3E-01	4.6E-05	1.6E-04	7%	Gastrointestinal system; irritation	- -	[D]			
Lead	3.2E-02	6.5E-02				CNS, blood	- -	[B2]			
Nickel	7.8E-02	1.6E-01	9.8E-06	3.6E-05	2%	dec. body and organ weight	300	- -			
Silver	2.2E-03	2.9E-03	1.1E-05	2.6E-05	1%	skin; argyria	3	[D]			
Zinc	2.7E-01	5.2E-01	1.4E-05	4.7E-05	2%	blood; anemia	3	[D]			
ORGANICS											
1,2-Dichloroethylene	3.0E-04	4.0E-04	1.3E-05	3.2E-05	1%	liver; hepatic lesions	1000	- -			
Trichloroethylene	3.0E-04	5.0E-04				- -	- -	- -			
Summed Hazard Quotient			MLE 7.48E-04	RME 2.32E-03	100%						
Summed Cancer Risk									MLE 5.93E-08	RME 6.43E-07	100%

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

TABLE H-89. RISK FROM FILTERED GROUNDWATER DERMAL CONTACT BY RESIDENT ADULT - FUTURE CONDITIONS
BACKGROUND SITE, 178th TACTICAL FIGHTER GROUP, SPRINGFIELD ANGB, SPRINGFIELD, OHIO

Chemical	Exposure Point Concentration in Groundwater (mg/l) MLE	Exposure Point Concentration in Groundwater (mg/l) RME	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) MLE	Noncarcinogenic Effects: Hazard Quotient (Intake/RfD) RME	RME % of total HQ	Target Organ System	UF (oral)	WOE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1) MLE	Carcinogenic Effects: Excess Lifetime Cancer Risk (ELCR) (Intake x q1) RME	RME % of total ELCR
INORGANICS											
Antimony (d)	1.4E-03	1.9E-03	8.8E-05	2.2E-04	100%	whole body, blood; inc. mortality	1000	- -			
Lead (d)	1.9E-03	5.7E-03				CNS, blood	- -	[B2]			
Summed Hazard Quotient			MLE 8.79E-05	RME 2.17E-04	100%						
Summed Cancer Risk									MLE --	RME --	

RME - Reasonable Maximum Exposure
MLE - Most Likely Exposure
EPC - Exposure Point Concentration
UF - Noncancer Uncertainty Factor
WOE - Cancer Weight of Evidence
RfD - Reference Dose
q1 - Cancer Slope Factor

Table H-90. LEAD 0.6 Uptake/Biokinetic Model Assumptions[b] and Results 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

	Site 2	Site 3	Site 5	Background (total) [a]	Background (dissolved) [a]
Lead Concentration in Soil (mg/kg)	72.59	47.4	255.9	70.45	70.45
Lead Concentration in Groundwater (μg/L)	197	62.4	[b]	65.2	5.7
Lead Concentration in Air ($\mu g/m^3$)	1.57×10^{-5}	1.02×10^{-5}	5.29×10^{-5}	1.52×10^{-5}	1.52×10^{-5}
Geometric Mean of the Projected Blood Lead Level (μg Pb/dL blood)	18.42	6.71	4.25	7.13	2.21
Sensitive Age Group (months)	72 to 84	72 to 84	36 to 48	72 to 84	36 to 48
Percentile Exceeding 10 μg Pb/dL blood Lead Level	**94.61**	**11.84**	**0.68**	**15.47**	**0.00**

[a] Total and dissolved lead concentrations in groundwater were used for the analysis of background samples.
[b] Monitoring data and default LEAD 0.6 intake assumptions were used in the model, with the following exceptions:

- the particulate emission factor, in conjunction with measured lead concentrations in soil, was used to calculate airborne lead concentrations (10^{-7} to 10^{-9} μg/m3) in place of the default setting (0.200 $\mu g/m^3$), and
- since no groundwater samples were collected from Site 5, the default lead concentration in drinking water, 4 μg/L, was used.

TABLE H-91. Volatilization Factors (VF) for Site 2
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio
(calculated from RAGS, Part B)

	Length of side LS (m)	Wind speed V (m/s)	Diffusion height DH (m)	Area of contamination A (cm^2)	Effective Diffusivity D_{ef} (cm^2/s)	True soil porosity E (unitless)	Soil/air part. coefficient K_{as} (g soil/cm^3 air)	True soil density p_s (g/cm^3)	Exposure interval T (s)	Molecular diffusivity D_i (cm^2/s)	Henry's law constant H (atm-m^3/mol)	Soil/water part. coeff. K_d (cm^3/g)	Org. carbon part. coeff. K_{OC} (cm^3/g)	Fraction of org. carbon OC (unitless)	alpha	VF (m^3/kg)
Source:	a	b	b	a	c	b	d	b	b	e	e	f	g	b	h	--
Acenaphthene	25	2.25	2	6.25E+06	2.98E-02	0.35	8.89E-01	2.65	7.90E+08	4.21E-02	7.71E-03	3.56E-01	17.783	0.02	4.55E-03	3.27E+03
Acenaphthylene	25	2.25	2	6.25E+06	3.10E-02	0.35	4.88E-05	2.65	7.90E+08	4.39E-02	1.14E-04	9.57E+01	4786.301	0.02	3.08E-07	4.69E+05
Acetone	25	2.25	2	6.25E+06	8.77E-02	0.35	1.38E-01	2.65	7.90E+08	1.24E-01	2.50E-05	7.43E-03	0.3715	0.02	2.39E-03	5.18E+03
Anthracene	25	2.25	2	6.25E+06	2.29E-02	0.35	7.43E-03	2.65	7.90E+08	3.24E-02	6.75E-02	3.72E+02	18620	0.02	3.45E-05	4.42E+04
Benzene	25	2.25	2	6.25E+06	6.22E-02	0.35	1.36E-01	2.65	7.90E+08	8.80E-02	5.50E-03	1.66E+00	83.176	0.02	1.67E-03	6.20E+03
Benzo(a)anthracene	25	2.25	2	6.25E+06	3.61E-02	0.35	2.05E-12	2.65	7.90E+08	5.10E-02	1.38E-09	2.76E+04	1380384	0.02	1.50E-14	2.12E+09
Benzo(a)pyrene	25	2.25	2	6.25E+06	3.04E-02	0.35	3.21E-12	2.65	7.90E+08	4.30E-02	1.38E-09	1.76E+04	881049	0.02	1.98E-14	1.85E+09
Benzo(b)flouranthene	25	2.25	2	6.25E+06	-	0.35	-	2.65	7.90E+08	0.00E+00	-	1.10E+04	549541	0.02	-	-
Benzo(g,h,i)perylene	25	2.25	2	6.25E+06	-	0.35	-	2.65	7.90E+08	-	-	1.55E+05	7762471	0.02	-	-
Benzo(k)fluoranthene	25	2.25	2	6.25E+06	1.60E-02	0.35	5.17E-13	2.65	7.90E+08	2.26E-02	1.10E-09	8.73E+04	4365158	0.02	1.68E-15	6.35E+09
2-Butanone	25	2.25	2	6.25E+06	5.71E-02	0.35	7.25E-02	2.65	7.90E+08	8.08E-02	4.35E-05	2.46E-02	1.2303	0.02	8.29E-04	8.91E+03
Carbazole	25	2.25	2	6.25E+06	-	0.35	-	2.65	7.90E+08	-	-	-	-	0.02	-	-
Carbon Disulfide	25	2.25	2	6.25E+06	7.35E-02	0.35	1.18E-01	2.65	7.90E+08	1.04E-01	1.68E-02	5.83E+00	291.7427	0.02	1.72E-03	6.12E+03
Chrysene	25	2.25	2	6.25E+06	1.75E-02	0.35	9.85E-12	2.65	7.90E+08	2.48E-02	1.18E-09	4.91E+03	245471	0.02	3.51E-14	1.39E+09
Dibenzo(a,h)anthrace	25	2.25	2	6.25E+06	1.41E-02	0.35	4.71E-11	2.65	7.90E+08	2.00E-02	3.81E-08	3.32E+04	1659587	0.02	1.35E-13	7.08E+08
Dibenzofuran	25	2.25	2	6.25E+06	-	0.35	-	2.65	7.90E+08	-	-	2.02E+02	10115.79	0.02	-	-
1,2-Dichloroethylene	25	2.25	2	6.25E+06	5.20E-02	0.35	1.11E+00	2.65	7.90E+08	7.36E-02	3.19E-02	1.18E+00	58.884	0.02	9.58E-03	2.17E+03
Di-n-octylphthalate	25	2.25	2	6.25E+06	-	0.35	-	2.65	7.90E+08	-	-	1.95E+07	9.77E+08	0.02	-	-
Ethylbenzene	25	2.25	2	6.25E+06	5.30E-02	0.35	1.38E-01	2.65	7.90E+08	7.50E-02	6.44E-03	1.91E+00	95.499	0.02	1.45E-03	6.65E+03
Fluoranthene	25	2.25	2	6.25E+06	2.14E-02	0.35	3.31E-03	2.65	7.90E+08	3.02E-02	6.73E-02	8.34E+02	41686.94	0.02	1.44E-05	6.86E+04
Fluorene	25	2.25	2	6.25E+06	2.57E-02	0.35	4.79E-05	2.65	7.90E+08	3.63E-02	1.17E-04	1.00E+02	5011.872	0.02	2.50E-07	5.21E+05
Indeno(1,2,3-cd)pyren	25	2.25	2	6.25E+06	1.64E-02	0.35	3.36E-17	2.65	7.90E+08	2.32E-02	5.07E-13	6.18E+05	30902954	0.02	1.12E-19	7.77E+11
Isophorone	25	2.25	2	6.25E+06	4.41E-02	0.35	3.83E-04	2.65	7.90E+08	6.23E-02	5.78E-06	6.18E-01	30.903	0.02	3.43E-06	1.40E+05
2-Methylnaphthalene	25	2.25	2	6.25E+06	3.39E-02	0.35	1.40E-05	2.65	7.90E+08	4.80E-02	5.80E-05	1.70E+02	8511.38	0.02	9.64E-08	8.38E+05
4-Methyl-2-pentanone	25	2.25	2	6.25E+06	5.30E-02	0.35	1.65E-02	2.65	7.90E+08	7.50E-02	4.95E-05	1.23E-01	6.166	0.02	1.77E-04	1.95E+04
Naphthalene	25	2.25	2	6.25E+06	4.17E-02	0.35	1.88E-03	2.65	7.90E+08	5.90E-02	1.18E-03	2.58E+01	1288.25	0.02	1.59E-05	6.52E+04
N-nitroso-di-n-propyl	25	2.25	2	6.25E+06	-	0.35	-	2.65	7.90E+08	-	-	2.05E-01	10.2329	0.02	-	-
Pentachlorophenol	25	2.25	2	6.25E+06	3.96E-02	0.35	2.02E-04	2.65	7.90E+08	5.60E-02	8.80E-05	1.78E+01	891.251	0.02	1.63E-06	2.04E+05
Phenanthrene	25	2.25	2	6.25E+06	2.35E-02	0.35	5.41E-04	2.65	7.90E+08	3.33E-02	6.05E-03	4.58E+02	22908.68	0.02	2.59E-06	1.62E+05
Pyrene	25	2.25	2	6.25E+06	1.92E-02	0.35	1.89E-10	2.65	7.90E+08	2.72E-02	7.00E-09	1.52E+03	75857.76	0.02	7.39E-13	3.03E+08
Tetrachloroethylene	25	2.25	2	6.25E+06	5.09E-02	0.35	2.26E-01	2.65	7.90E+08	7.20E-02	2.90E-02	5.26E+00	263.027	0.02	2.24E-03	5.26E+03
Toluene	25	2.25	2	6.25E+06	6.15E-02	0.35	1.19E-01	2.65	7.90E+08	8.70E-02	6.68E-03	2.30E+00	114.815	0.02	1.46E-03	6.66E+03
Trichloroethylene	25	2.25	2	6.25E+06	5.59E-02	0.35	1.76E-01	2.65	7.90E+08	7.90E-02	9.10E-03	2.12E+00	105.93	0.02	1.93E-03	5.72E+03
Xylenes	25	2.25	2	6.25E+06	5.44E-02	0.35	5.27E-02	2.65	7.90E+08	7.69E-02	5.25E-03	4.08E+00	204.17	0.02	5.76E-04	1.07E+04

Source:
a - site specific value
b - default recommended in RAGS, Vol. I, Part B
c - $D_{ef} = D_i * E^{(0.33)}$
d - $K_{as} = (H/K_d) * 41$
e - EPA, Office of Air Quality, Planning, and Standards; CHEMDAT7 Air Emissions Program
f - $K_d = K_{OC} * OC$
g - Groundwater Chemicals Desk Reference
h - alpha = $(D_{ef} * E)/(E+(p_s)(1-E)/K_{as})$

TABLE H-92. Volatilization Factors (VF) for Site 3
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio
(calculated from RAGS, Part B)

	Length of side LS (m)	Wind speed V (m/s)	Diffusion height DH (m)	Area of contamination A (cm^2)	Effective Diffusivity D_{ef} (cm^2/s)	True soil porosity E (unitless)	oil/air partitio coefficient K_{as} (g soil/cm^3 air)	True soil density p_s (g/cm^3)	Exposure interval T (s)	Molecular diffusivity D_i (cm^2/s)	Henry's law constant H (atm-m^3/mol)	Soil/water part. coeff. K_d (cm^3/g)	Org. carbon part. coeff. K_{OC} (cm^3/g)	Fraction of org. carbon OC (unitless)	alpha	VF (m^3/kg)
Source:	a	b	b	a	c	b	d	b	b	e	e	f	g	b	h	--
Acenaphthene	30	2.25	2	9.00E+06	2.98E-02	0.35	8.89E-01	2.65	7.90E+08	4.21E-02	7.71E-03	3.56E-01	17.783	0.02	4.55E-03	2.72E+03
Acenaphthylene	30	2.25	2	9.00E+06	3.10E-02	0.35	4.88E-05	2.65	7.90E+08	4.39E-02	1.14E-04	9.57E+01	4786.301	0.02	3.08E-07	3.91E+05
Acetone	30	2.25	2	9.00E+06	8.77E-02	0.35	1.38E-01	2.65	7.90E+08	1.24E-01	2.50E-05	7.43E-03	0.3715	0.02	2.39E-03	4.31E+03
Anthracene	30	2.25	2	9.00E+06	2.29E-02	0.35	7.43E-03	2.65	7.90E+08	3.24E-02	6.75E-02	3.72E+02	18620	0.02	3.45E-05	3.68E+04
Benzene	30	2.25	2	9.00E+06	6.22E-02	0.35	1.36E-01	2.65	7.90E+08	8.80E-02	5.50E-03	1.66E+00	83.176	0.02	1.67E-03	5.17E+03
Benzo(a)anthracene	30	2.25	2	9.00E+06	3.61E-02	0.35	2.05E-12	2.65	7.90E+08	5.10E-02	1.38E-09	2.76E+04	1380384	0.02	1.50E-14	1.77E+09
Benzo(a)pyrene	30	2.25	2	9.00E+06	3.04E-02	0.35	3.21E-12	2.65	7.90E+08	4.30E-02	1.38E-09	1.76E+04	881049	0.02	1.98E-14	1.54E+09
Benzo(b)flouranthene	30	2.25	2	9.00E+06	-	0.35	-	2.65	7.90E+08	0.00E+00	-	1.10E+04	549541	0.02	-	-
Benzo(g,h,i)perylene	30	2.25	2	9.00E+06	-	0.35	-	2.65	7.90E+08	-	-	1.55E+05	7762471	0.02	-	-
Benzo(k)fluoranthene	30	2.25	2	9.00E+06	1.60E-02	0.35	5.17E-13	2.65	7.90E+08	2.26E-02	1.10E-09	8.73E+04	4365158	0.02	1.68E-15	5.29E+09
2-Butanone	30	2.25	2	9.00E+06	5.71E-02	0.35	7.25E-02	2.65	7.90E+08	8.08E-02	4.35E-05	2.46E-02	1.2303	0.02	8.29E-04	7.42E+03
Carbazole	30	2.25	2	9.00E+06	-	0.35	-	2.65	7.90E+08	-	-	-	-	0.02	-	-
Carbon Disulfide	30	2.25	2	9.00E+06	7.35E-02	0.35	1.18E-01	2.65	7.90E+08	1.04E-01	1.68E-02	5.83E+00	291.7427	0.02	1.72E-03	5.10E+03
Chrysene	30	2.25	2	9.00E+06	1.75E-02	0.35	9.85E-12	2.65	7.90E+08	2.48E-02	1.18E-09	4.91E+03	245471	0.02	3.51E-14	1.16E+09
Dibenzo(a,h)anthrace	30	2.25	2	9.00E+06	1.41E-02	0.35	4.71E-11	2.65	7.90E+08	2.00E-02	3.81E-08	3.32E+04	1659587	0.02	1.35E-13	5.90E+08
Dibenzofuran	30	2.25	2	9.00E+06	-	0.35	-	2.65	7.90E+08	-	-	2.02E+02	10115.79	0.02	-	-
1,2-Dichloroethylene	30	2.25	2	9.00E+06	5.20E-02	0.35	1.11E+00	2.65	7.90E+08	7.36E-02	3.19E-02	1.18E+00	58.884	0.02	9.58E-03	1.81E+03
Di-n-octylphthalate	30	2.25	2	9.00E+06	-	0.35	-	2.65	7.90E+08	-	-	1.95E+07	9.77E+08	0.02	-	-
Ethylbenzene	30	2.25	2	9.00E+06	5.30E-02	0.35	1.38E-01	2.65	7.90E+08	7.50E-02	6.44E-03	1.91E+00	95.499	0.02	1.45E-03	5.54E+03
Fluoranthene	30	2.25	2	9.00E+06	2.14E-02	0.35	3.31E-03	2.65	7.90E+08	3.02E-02	6.73E-02	8.34E+02	41686.94	0.02	1.44E-05	5.72E+04
Fluorene	30	2.25	2	9.00E+06	2.57E-02	0.35	4.79E-05	2.65	7.90E+08	3.63E-02	1.17E-04	1.00E+02	5011.872	0.02	2.50E-07	4.34E+05
Indeno(1,2,3-cd)pyren	30	2.25	2	9.00E+06	1.64E-02	0.35	3.36E-17	2.65	7.90E+08	2.32E-02	5.07E-13	6.18E+05	30902954	0.02	1.12E-19	6.48E+11
Isophorone	30	2.25	2	9.00E+06	4.41E-02	0.35	3.83E-04	2.65	7.90E+08	6.23E-02	5.78E-06	6.18E-01	30.903	0.02	3.43E-06	1.17E+05
2-Methylnaphthalene	30	2.25	2	9.00E+06	3.39E-02	0.35	1.40E-05	2.65	7.90E+08	4.80E-02	5.80E-05	1.70E+02	8511.38	0.02	9.64E-08	6.99E+05
4-Methyl-2-pentanone	30	2.25	2	9.00E+06	5.30E-02	0.35	1.65E-02	2.65	7.90E+08	7.50E-02	4.95E-05	1.23E-01	6.166	0.02	1.77E-04	1.63E+04
Naphthalene	30	2.25	2	9.00E+06	4.17E-02	0.35	1.88E-03	2.65	7.90E+08	5.90E-02	1.18E-03	2.58E+01	1288.25	0.02	1.59E-05	5.43E+04
N-nitroso-di-n-propyl	30	2.25	2	9.00E+06	-	0.35	-	2.65	7.90E+08	-	-	2.05E-01	10.2329	0.02	-	-
Pentachlorophenol	30	2.25	2	9.00E+06	3.96E-02	0.35	2.02E-04	2.65	7.90E+08	5.60E-02	8.80E-05	1.78E+01	891.251	0.02	1.63E-06	1.70E+05
Phenanthrene	30	2.25	2	9.00E+06	2.35E-02	0.35	5.41E-04	2.65	7.90E+08	3.33E-02	6.05E-03	4.58E+02	22908.68	0.02	2.59E-06	1.35E+05
Pyrene	30	2.25	2	9.00E+06	1.92E-02	0.35	1.89E-10	2.65	7.90E+08	2.72E-02	7.00E-09	1.52E+03	75857.76	0.02	7.39E-13	2.52E+08
Tetrachloroethylene	30	2.25	2	9.00E+06	5.09E-02	0.35	2.26E-01	2.65	7.90E+08	7.20E-02	2.90E-02	5.26E+00	263.027	0.02	2.24E-03	4.38E+03
Toluene	30	2.25	2	9.00E+06	6.15E-02	0.35	1.19E-01	2.65	7.90E+08	8.70E-02	6.68E-03	2.30E+00	114.815	0.02	1.46E-03	5.55E+03
Trichloroethylene	30	2.25	2	9.00E+06	5.59E-02	0.35	1.76E-01	2.65	7.90E+08	7.90E-02	9.10E-03	2.12E+00	105.93	0.02	1.93E-03	4.77E+03
Xylenes	30	2.25	2	9.00E+06	5.44E-02	0.35	5.27E-02	2.65	7.90E+08	7.69E-02	5.25E-03	4.08E+00	204.17	0.02	5.76E-04	8.94E+03

Source:
a - site specific value
b - default recommended in RAGS, Vol. I, Part B
c - $D_{ef} = D_i * E^{(0.33)}$
d - $K_{as} = (H/K_d) * 41$
e - EPA, Office of Air Quality, Planning, and Standards; CHEMDAT7 Air Emissions Program
f - $K_d = K_{OC} * OC$
g - Groundwater Chemicals Desk Reference
h - alpha = $(D_{ef} * E)/(E+(p_s)(1-E)/K_{as})$

TABLE H-93. Volatilization Factors (VF) for Site 5
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio
(calculated from RAGS, Part B)

	Length of side LS (m)	Wind speed V (m/s)	Diffusion height DH (m)	Area of contamination A (cm^2)	Effective Diffusivity D_{ef} (cm^2/s)	True soil porosity E (unitless)	oil/air partitio coefficient K_{as} (g soil/cm^3 air)	True soil density p_s (g/cm^3)	Exposure interval T (s)	Molecular diffusivity D_i (cm^2/s)	Henry's law constant H (atm-m^3/mol)	Soil/water part. coeff. K_d (cm^3/g)	Org. carbon part. coeff. K_{OC} (cm^3/g)	Fraction of org. carbon OC (unitless)	alpha	VF (m^3/kg)
Source:	a	b	b	a	c	b	d	b	b	e	e	f	g	b	h	--
Acenaphthene	59	2.25	2	3.45E+07	2.98E-02	0.35	8.89E-01	2.65	7.90E+08	4.21E-02	7.71E-03	3.56E-01	17.783	0.02	4.55E-03	1.40E+03
Acenaphthylene	59	2.25	2	3.45E+07	3.10E-02	0.35	4.88E-05	2.65	7.90E+08	4.39E-02	1.14E-04	9.57E+01	4786.301	0.02	3.08E-07	2.00E+05
Acetone	59	2.25	2	3.45E+07	8.77E-02	0.35	1.38E-01	2.65	7.90E+08	1.24E-01	2.50E-05	7.43E-03	0.3715	0.02	2.39E-03	2.21E+03
Anthracene	59	2.25	2	3.45E+07	2.29E-02	0.35	7.43E-03	2.65	7.90E+08	3.24E-02	6.75E-02	3.72E+02	18620	0.02	3.45E-05	1.89E+04
Benzene	59	2.25	2	3.45E+07	6.22E-02	0.35	1.36E-01	2.65	7.90E+08	8.80E-02	5.50E-03	1.66E+00	83.176	0.02	1.67E-03	2.65E+03
Benzo(a)anthracene	59	2.25	2	3.45E+07	3.61E-02	0.35	2.05E-12	2.65	7.90E+08	5.10E-02	1.38E-09	2.76E+04	1380384	0.02	1.50E-14	9.08E+08
Benzo(a)pyrene	59	2.25	2	3.45E+07	3.04E-02	0.35	3.21E-12	2.65	7.90E+08	4.30E-02	1.38E-09	1.76E+04	881049	0.02	1.98E-14	7.90E+08
Benzo(b)flouranthene	59	2.25	2	3.45E+07	-	0.35	-	2.65	7.90E+08	0.00E+00	-	1.10E+04	549541	0.02	-	-
Benzo(g,h,i)perylene	59	2.25	2	3.45E+07	-	0.35	-	2.65	7.90E+08	-	-	1.55E+05	7762471	0.02	-	-
Benzo(k)fluoranthene	59	2.25	2	3.45E+07	1.60E-02	0.35	5.17E-13	2.65	7.90E+08	2.26E-02	1.10E-09	8.73E+04	4365158	0.02	1.68E-15	2.72E+09
2-Butanone	59	2.25	2	3.45E+07	5.71E-02	0.35	7.25E-02	2.65	7.90E+08	8.08E-02	4.35E-05	2.46E-02	1.2303	0.02	8.29E-04	3.81E+03
Carbazole	59	2.25	2	3.45E+07	-	0.35	-	2.65	7.90E+08	-	-	-	-	0.02	-	-
Carbon Disulfide	59	2.25	2	3.45E+07	7.35E-02	0.35	1.18E-01	2.65	7.90E+08	1.04E-01	1.68E-02	5.83E+00	291.7427	0.02	1.72E-03	2.62E+03
Chrysene	59	2.25	2	3.45E+07	1.75E-02	0.35	9.85E-12	2.65	7.90E+08	2.48E-02	1.18E-09	4.91E+03	245471	0.02	3.51E-14	5.94E+08
Dibenzo(a,h)anthrace	59	2.25	2	3.45E+07	1.41E-02	0.35	4.71E-11	2.65	7.90E+08	2.00E-02	3.81E-08	3.32E+04	1659587	0.02	1.35E-13	3.03E+08
Dibenzofuran	59	2.25	2	3.45E+07	-	0.35	-	2.65	7.90E+08	-	-	2.02E+02	10115.79	0.02	-	-
1,2-Dichloroethylene	59	2.25	2	3.45E+07	5.20E-02	0.35	1.11E+00	2.65	7.90E+08	7.36E-02	3.19E-02	1.18E+00	58.884	0.02	9.58E-03	9.27E+02
Di-n-octylphthalate	59	2.25	2	3.45E+07	-	0.35	-	2.65	7.90E+08	-	-	1.95E+07	9.77E+08	0.02	-	-
Ethylbenzene	59	2.25	2	3.45E+07	5.30E-02	0.35	1.38E-01	2.65	7.90E+08	7.50E-02	6.44E-03	1.91E+00	95.499	0.02	1.45E-03	2.84E+03
Fluoranthene	59	2.25	2	3.45E+07	2.14E-02	0.35	3.31E-03	2.65	7.90E+08	3.02E-02	6.73E-02	8.34E+02	41686.94	0.02	1.44E-05	2.93E+04
Fluorene	59	2.25	2	3.45E+07	2.57E-02	0.35	4.79E-05	2.65	7.90E+08	3.63E-02	1.17E-04	1.00E+02	5011.872	0.02	2.50E-07	2.23E+05
Indeno(1,2,3-cd)pyren	59	2.25	2	3.45E+07	1.64E-02	0.35	3.36E-17	2.65	7.90E+08	2.32E-02	5.07E-13	6.18E+05	30902954	0.02	1.12E-19	3.32E+11
Isophorone	59	2.25	2	3.45E+07	4.41E-02	0.35	3.83E-04	2.65	7.90E+08	6.23E-02	5.78E-06	6.18E-01	30.903	0.02	3.43E-06	6.00E+04
2-Methylnaphthalene	59	2.25	2	3.45E+07	3.39E-02	0.35	1.40E-05	2.65	7.90E+08	4.80E-02	5.80E-05	1.70E+02	8511.38	0.02	9.64E-08	3.58E+05
4-Methyl-2-pentanone	59	2.25	2	3.45E+07	5.30E-02	0.35	1.65E-02	2.65	7.90E+08	7.50E-02	4.95E-05	1.23E-01	6.166	0.02	1.77E-04	8.34E+03
Naphthalene	59	2.25	2	3.45E+07	4.17E-02	0.35	1.88E-03	2.65	7.90E+08	5.90E-02	1.18E-03	2.58E+01	1288.25	0.02	1.59E-05	2.79E+04
N-nitroso-di-n-propyl	59	2.25	2	3.45E+07	-	0.35	-	2.65	7.90E+08	-	-	2.05E-01	10.2329	0.02	-	-
Pentachlorophenol	59	2.25	2	3.45E+07	3.96E-02	0.35	2.02E-04	2.65	7.90E+08	5.60E-02	8.80E-05	1.78E+01	891.251	0.02	1.63E-06	8.72E+04
Phenanthrene	59	2.25	2	3.45E+07	2.35E-02	0.35	5.41E-04	2.65	7.90E+08	3.33E-02	6.05E-03	4.58E+02	22908.68	0.02	2.59E-06	6.91E+04
Pyrene	59	2.25	2	3.45E+07	1.92E-02	0.35	1.89E-10	2.65	7.90E+08	2.72E-02	7.00E-09	1.52E+03	75857.76	0.02	7.39E-13	1.29E+08
Tetrachloroethylene	59	2.25	2	3.45E+07	5.09E-02	0.35	2.26E-01	2.65	7.90E+08	7.20E-02	2.90E-02	5.26E+00	263.027	0.02	2.24E-03	2.25E+03
Toluene	59	2.25	2	3.45E+07	6.15E-02	0.35	1.19E-01	2.65	7.90E+08	8.70E-02	6.68E-03	2.30E+00	114.815	0.02	1.46E-03	2.85E+03
Trichloroethylene	59	2.25	2	3.45E+07	5.59E-02	0.35	1.76E-01	2.65	7.90E+08	7.90E-02	9.10E-03	2.12E+00	105.93	0.02	1.93E-03	2.44E+03
Xylenes	59	2.25	2	3.45E+07	5.44E-02	0.35	5.27E-02	2.65	7.90E+08	7.69E-02	5.25E-03	4.08E+00	204.17	0.02	5.76E-04	4.59E+03

Source:
a - site specific value
b - default recommended in RAGS, Vol. I, Part B
c - $D_{ef} = D_i * E^{(0.33)}$
d - $K_{as} = (H/K_d) * 41$
e - EPA, Office of Air Quality, Planning, and Standards; CHEMDAT7 Air Emissions Program
f - $K_d = K_{OC} * OC$
g - Groundwater Chemicals Desk Reference
h - alpha = $(D_{ef} * E)/(E+(p_s)(1-E)/K_{as})$

TABLE H-94. Volatilization Factors (VF) for Background
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio
(calculated from RAGS, Part B)

	Length of side LS (m)	Wind speed V (m/s)	Diffusion height DH (m)	Area of contamination A (cm^2)	Effective Diffusivity D_{ef} (cm^2/s)	True soil porosity E (unitless)	oil/air partitio coefficient K_{as} (g soil/cm^3 air)	True soil density p_s (g/cm^3)	Exposure interval T (s)	Molecular diffusivity D_i (cm^2/s)	Henry's law constant H (atm-m^3/mol)	Soil/water part. coeff. K_d (cm^3/g)	Org. carbon part. coeff. K_{OC} (cm^3/g)	Fraction of org. carbon OC (unitless)	alpha	VF (m^3/kg)
Source:	a	b	b	a	c	b	d	b	b	e	e	f	g	b	h	--
Acenaphthene	45	2.25	2	2.03E+07	2.98E-02	0.35	8.89E-01	2.65	7.90E+08	4.21E-02	7.71E-03	3.56E-01	17.783	0.02	4.55E-03	1.81E+03
Acenaphthylene	45	2.25	2	2.03E+07	3.10E-02	0.35	4.88E-05	2.65	7.90E+08	4.39E-02	1.14E-04	9.57E+01	4786.301	0.02	3.08E-07	2.60E+05
Acetone	45	2.25	2	2.03E+07	8.77E-02	0.35	1.38E-01	2.65	7.90E+08	1.24E-01	2.50E-05	7.43E-03	0.3715	0.02	2.39E-03	2.88E+03
Anthracene	45	2.25	2	2.03E+07	2.29E-02	0.35	7.43E-03	2.65	7.90E+08	3.24E-02	6.75E-02	3.72E+02	18620	0.02	3.45E-05	2.46E+04
Benzene	45	2.25	2	2.03E+07	6.22E-02	0.35	1.36E-01	2.65	7.90E+08	8.80E-02	5.50E-03	1.66E+00	83.176	0.02	1.67E-03	3.44E+03
Benzo(a)anthracene	45	2.25	2	2.03E+07	3.61E-02	0.35	2.05E-12	2.65	7.90E+08	5.10E-02	1.38E-09	2.76E+04	1380384	0.02	1.50E-14	1.18E+09
Benzo(a)pyrene	45	2.25	2	2.03E+07	3.04E-02	0.35	3.21E-12	2.65	7.90E+08	4.30E-02	1.38E-09	1.76E+04	881049	0.02	1.98E-14	1.03E+09
Benzo(b)flouranthene	45	2.25	2	2.03E+07	-	0.35	-	2.65	7.90E+08	0.00E+00	-	1.10E+04	549541	0.02	-	-
Benzo(g,h,i)perylene	45	2.25	2	2.03E+07	-	0.35	-	2.65	7.90E+08	-	-	1.55E+05	7762471	0.02	-	-
Benzo(k)fluoranthene	45	2.25	2	2.03E+07	1.60E-02	0.35	5.17E-13	2.65	7.90E+08	2.26E-02	1.10E-09	8.73E+04	4365158	0.02	1.68E-15	3.53E+09
2-Butanone	45	2.25	2	2.03E+07	5.71E-02	0.35	7.25E-02	2.65	7.90E+08	8.08E-02	4.35E-05	2.46E-02	1.2303	0.02	8.29E-04	4.95E+03
Carbazole	45	2.25	2	2.03E+07	-	0.35	-	2.65	7.90E+08	-	-	-	-	0.02	-	-
Carbon Disulfide	45	2.25	2	2.03E+07	7.35E-02	0.35	1.18E-01	2.65	7.90E+08	1.04E-01	1.68E-02	5.83E+00	291.7427	0.02	1.72E-03	3.40E+03
Chrysene	45	2.25	2	2.03E+07	1.75E-02	0.35	9.85E-12	2.65	7.90E+08	2.48E-02	1.18E-09	4.91E+03	245471	0.02	3.51E-14	7.71E+08
Dibenzo(a,h)anthrace	45	2.25	2	2.03E+07	1.41E-02	0.35	4.71E-11	2.65	7.90E+08	2.00E-02	3.81E-08	3.32E+04	1659587	0.02	1.35E-13	3.93E+08
Dibenzofuran	45	2.25	2	2.03E+07	-	0.35	-	2.65	7.90E+08	-	-	2.02E+02	10115.79	0.02	-	-
1,2-Dichloroethylene	45	2.25	2	2.03E+07	5.20E-02	0.35	1.11E+00	2.65	7.90E+08	7.36E-02	3.19E-02	1.18E+00	58.884	0.02	9.58E-03	1.20E+03
Di-n-octylphthalate	45	2.25	2	2.03E+07	-	0.35	-	2.65	7.90E+08	-	-	1.95E+07	9.77E+08	0.02	-	-
Ethylbenzene	45	2.25	2	2.03E+07	5.30E-02	0.35	1.38E-01	2.65	7.90E+08	7.50E-02	6.44E-03	1.91E+00	95.499	0.02	1.45E-03	3.69E+03
Fluoranthene	45	2.25	2	2.03E+07	2.14E-02	0.35	3.31E-03	2.65	7.90E+08	3.02E-02	6.73E-02	8.34E+02	41686.94	0.02	1.44E-05	3.81E+04
Fluorene	45	2.25	2	2.03E+07	2.57E-02	0.35	4.79E-05	2.65	7.90E+08	3.63E-02	1.17E-04	1.00E+02	5011.872	0.02	2.50E-07	2.89E+05
Indeno(1,2,3-cd)pyren	45	2.25	2	2.03E+07	1.64E-02	0.35	3.36E-17	2.65	7.90E+08	2.32E-02	5.07E-13	6.18E+05	30902954	0.02	1.12E-19	4.32E+11
Isophorone	45	2.25	2	2.03E+07	4.41E-02	0.35	3.83E-04	2.65	7.90E+08	6.23E-02	5.78E-06	6.18E-01	30.903	0.02	3.43E-06	7.80E+04
2-Methylnaphthalene	45	2.25	2	2.03E+07	3.39E-02	0.35	1.40E-05	2.65	7.90E+08	4.80E-02	5.80E-05	1.70E+02	8511.38	0.02	9.64E-08	4.66E+05
4-Methyl-2-pentanone	45	2.25	2	2.03E+07	5.30E-02	0.35	1.65E-02	2.65	7.90E+08	7.50E-02	4.95E-05	1.23E-01	6.166	0.02	1.77E-04	1.08E+04
Naphthalene	45	2.25	2	2.03E+07	4.17E-02	0.35	1.88E-03	2.65	7.90E+08	5.90E-02	1.18E-03	2.58E+01	1288.25	0.02	1.59E-05	3.62E+04
N-nitroso-di-n-propyl	45	2.25	2	2.03E+07	-	0.35	-	2.65	7.90E+08	-	-	2.05E-01	10.2329	0.02	-	-
Pentachlorophenol	45	2.25	2	2.03E+07	3.96E-02	0.35	2.02E-04	2.65	7.90E+08	5.60E-02	8.80E-05	1.78E+01	891.251	0.02	1.63E-06	1.13E+05
Phenanthrene	45	2.25	2	2.03E+07	2.35E-02	0.35	5.41E-04	2.65	7.90E+08	3.33E-02	6.05E-03	4.58E+02	22908.68	0.02	2.59E-06	8.98E+04
Pyrene	45	2.25	2	2.03E+07	1.92E-02	0.35	1.89E-10	2.65	7.90E+08	2.72E-02	7.00E-09	1.52E+03	75857.76	0.02	7.39E-13	1.68E+08
Tetrachloroethylene	45	2.25	2	2.03E+07	5.09E-02	0.35	2.26E-01	2.65	7.90E+08	7.20E-02	2.90E-02	5.26E+00	263.027	0.02	2.24E-03	2.92E+03
Toluene	45	2.25	2	2.03E+07	6.15E-02	0.35	1.19E-01	2.65	7.90E+08	8.70E-02	6.68E-03	2.30E+00	114.815	0.02	1.46E-03	3.70E+03
Trichloroethylene	45	2.25	2	2.03E+07	5.59E-02	0.35	1.76E-01	2.65	7.90E+08	7.90E-02	9.10E-03	2.12E+00	105.93	0.02	1.93E-03	3.18E+03
Xylenes	45	2.25	2	2.03E+07	5.44E-02	0.35	5.27E-02	2.65	7.90E+08	7.69E-02	5.25E-03	4.08E+00	204.17	0.02	5.76E-04	5.96E+03

Source:
a - site specific value
b - default recommended in RAGS, Vol. I, Part B
c - $D_{ef} = D_i * E^{(0.33)}$
d - $K_{as} = (H/K_d) * 41$
e - EPA, Office of Air Quality, Planning, and Standards; CHEMDAT7 Air Emissions Program
f - $K_d = K_{OC} * OC$
g - Groundwater Chemicals Desk Reference
h - alpha = $(D_{ef} * E)/(E+(p_s)(1-E)/K_{as})$

Figure H-1. LEAD 0.6 Uptake/Biokinetic Model Results:
Site 2 - Fire Training Area 2
178th Tactical Fighter Group, Springfield-Beckley Municipal Airport, Springfield, Ohio

ABSORPTION METHODOLOGY: Non-Linear Active-Passive

AIR CONCENTRATION: 0.000 ug Pb/m3
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 197.00 ug Pb/L
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	72.6	72.6
1-2	72.6	72.6
2-3	72.6	72.6
3-4	72.6	72.6
4-5	72.6	72.6
5-6	72.6	72.6
6-7	72.6	72.6

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 7.50 ug Pb/dL

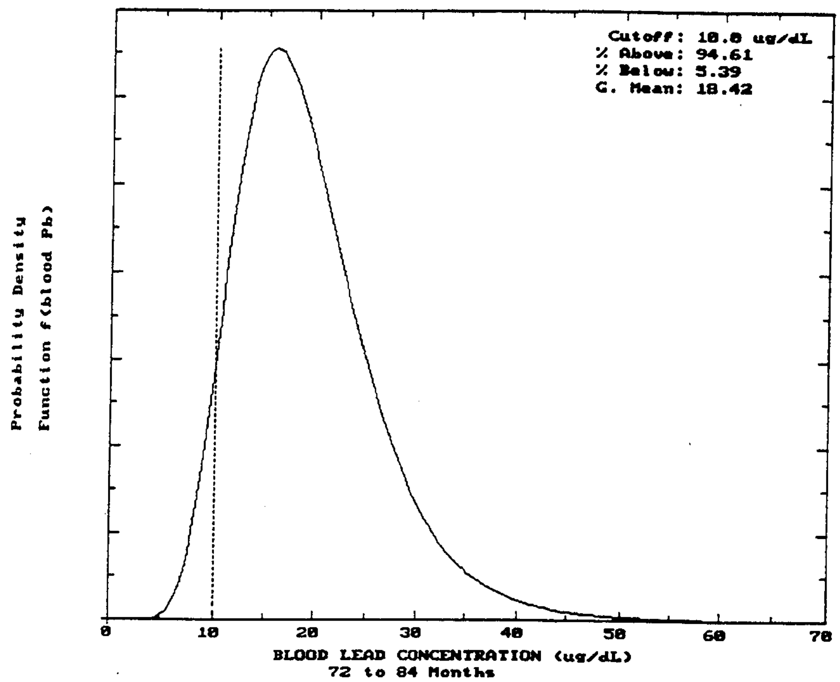
Figure H-1 (continued)

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	7.66	24.49	1.85
1-2:	13.05	55.15	2.94
2-3:	15.77	57.55	2.94
3-4:	16.66	58.43	2.94
4-5:	17.62	59.53	2.18
5-6:	18.16	62.46	1.96
6-7:	18.42	63.71	1.85

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	2.94	19.70	0.00	0.00
1-2:	2.96	49.25	0.00	0.00
2-3:	3.40	51.22	0.00	0.00
3-4:	3.29	52.20	0.00	0.00
4-5:	3.18	54.17	0.00	0.00
5-6:	3.38	57.13	0.00	0.00
6-7:	3.74	58.11	0.00	0.00

Figure H-2. LEAD 0.6 Uptake/Biokinetic Model Results: Site 2 - Fire Training Area 2, 178th Tactical Fighter Group, Springfield-Beckley Municipal Airport, Springfield, Ohio



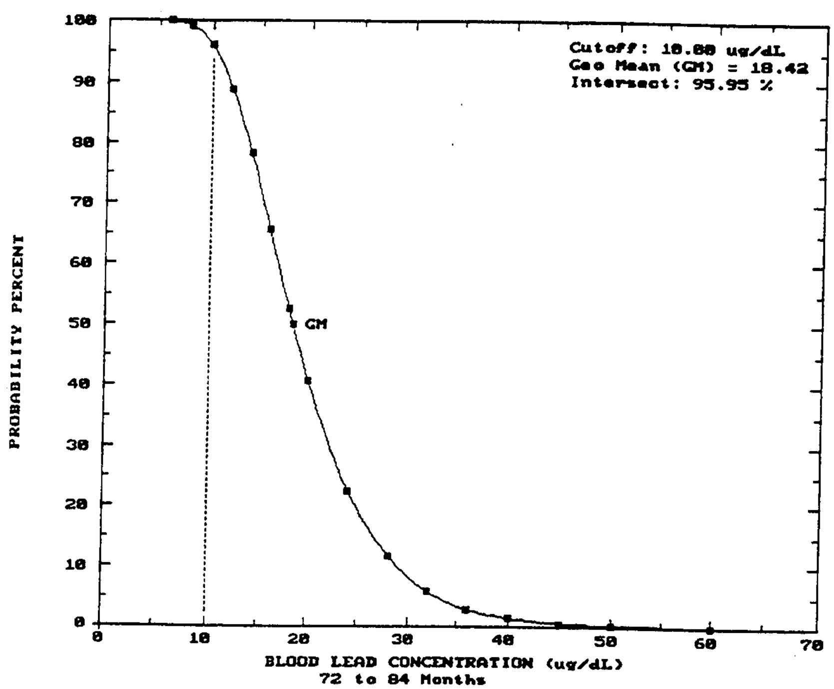


Figure H-3. LEAD 0.6 Uptake/Biokinetic Model Results:
Site 3 - Leach Field
178th Tactical Fighter Group, Springfield-Beckley Municipal Airport, Springfield, Ohio

ABSORPTION METHODOLOGY: Non-Linear Active-Passive

AIR CONCENTRATION: 0.000 ug Pb/m3
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 62.40 ug Pb/L
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	47.4	47.4
1-2	47.4	47.4
2-3	47.4	47.4
3-4	47.4	47.4
4-5	47.4	47.4
5-6	47.4	47.4
6-7	47.4	47.4

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 7.50 ug Pb/dL

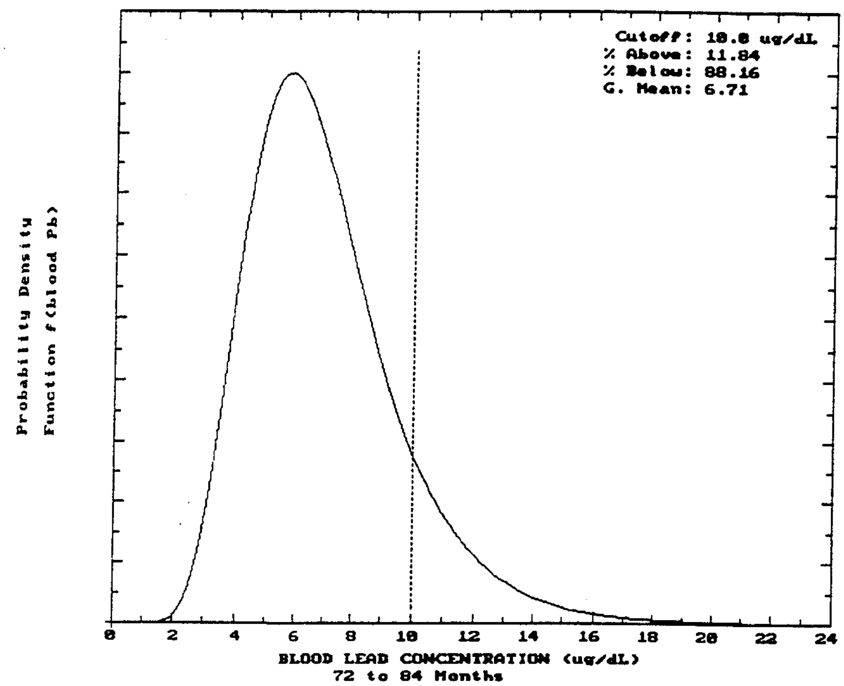
Figure H-3 (continued)

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
------	-----------	------------	------------
0.5-1:	3.59	10.39	1.21
1-2:	5.07	20.48	1.92
2-3:	5.91	21.54	1.92
3-4:	6.20	21.74	1.92
4-5:	6.48	21.76	1.42
5-6:	6.61	22.75	1.28
6-7:	6.71	23.36	1.21

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
------	-----------	------------	------------	---------
0.5-1:	2.94	6.24	0.00	0.00
1-2:	2.96	15.60	0.00	0.00
2-3:	3.40	16.22	0.00	0.00
3-4:	3.29	16.54	0.00	0.00
4-5:	3.18	17.16	0.00	0.00
5-6:	3.38	18.10	0.00	0.00
6-7:	3.74	18.41	0.00	0.00

Figure H-4. LEAD 0.6 Uptake/Biokinetic Model Results:
Site 3 - Leach Field, 178th Tactical Fighter Group,
Springfield-Beckley Municipal Airport, Springfield, Ohio



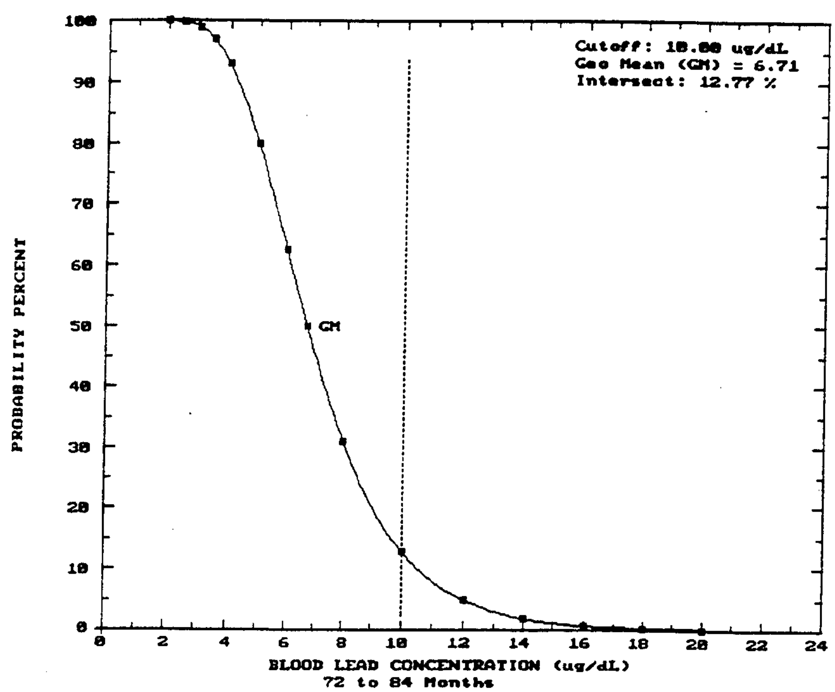


Figure H-5. LEAD 0.6 Uptake/Biokinetic Model Results:
Site 5 - Ramp Drainage Ditch
178th Tactical Fighter Group, Springfield-Beckley Municipal Airport, Springfield, Ohio

ABSORPTION METHODOLOGY: Non-Linear Active-Passive

AIR CONCENTRATION: 0.000 ug Pb/m3
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	255.9	255.9
1-2	255.9	255.9
2-3	255.9	255.9
3-4	255.9	255.9
4-5	255.9	255.9
5-6	255.9	255.9
6-7	255.9	255.9

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 7.50 ug Pb/dL

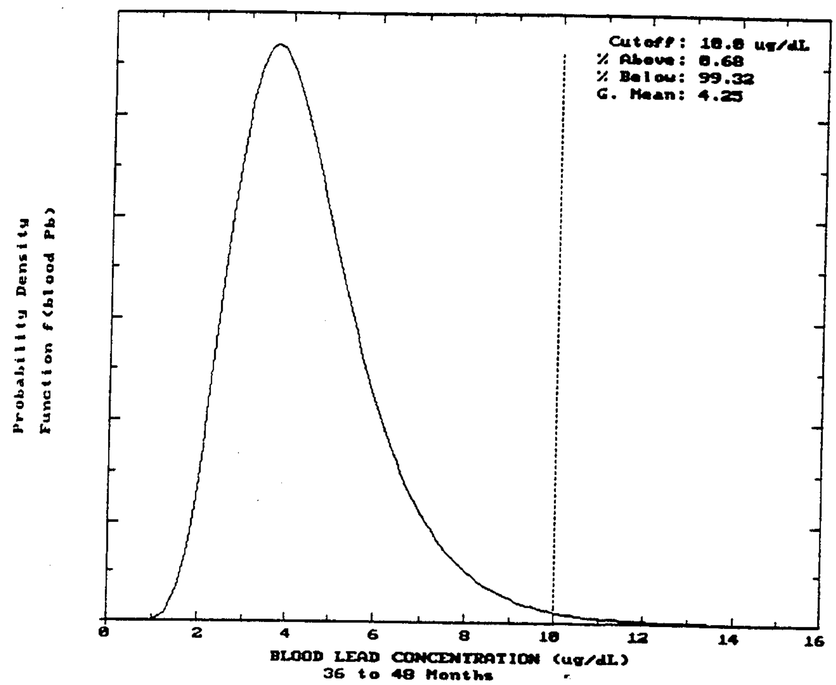
Figure H-5 (continued)

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	3.44	9.87	6.53
1-2:	3.86	14.32	10.36
2-3:	4.14	14.80	10.36
3-4:	4.25	14.71	10.36
4-5:	3.97	11.96	7.68
5-6:	3.60	11.44	6.91
6-7:	3.42	11.45	6.53

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	2.94	0.40	0.00	0.00
1-2:	2.96	1.00	0.00	0.00
2-3:	3.40	1.04	0.00	0.00
3-4:	3.29	1.06	0.00	0.00
4-5:	3.18	1.10	0.00	0.00
5-6:	3.38	1.16	0.00	0.00
6-7:	3.74	1.18	0.00	0.00

Figure H-6. LEAD 0.6 Uptake/Biokinetic Model Results: Site 5 - Ramp Drainage Ditch, 178th Tactical Fighter Group, Springfield-Beckley Municipal Airport, Springfield, Ohio



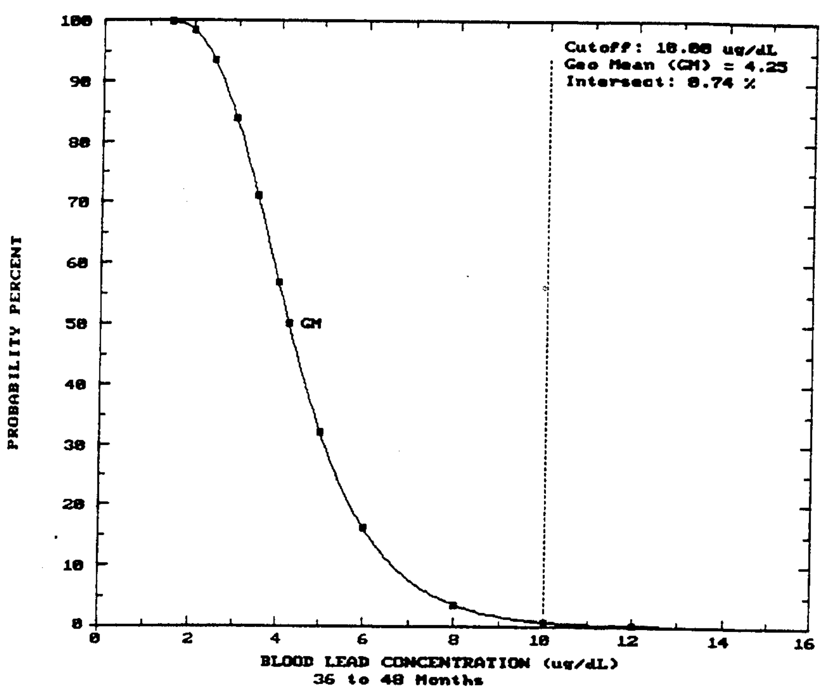


Figure H-7. LEAD 0.6 Uptake/Biokinetic Model Results: Background (total lead concentration in groundwater) 178th Tactical Fighter Group, Springfield-Beckley Municipal Airport, Springfield, Ohio

ABSORPTION METHODOLOGY: Non-Linear Active-Passive

AIR CONCENTRATION: 0.000 ug Pb/m3
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 65.20 ug Pb/L
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	70.4	70.4
1-2	70.4	70.4
2-3	70.4	70.4
3-4	70.4	70.4
4-5	70.4	70.4
5-6	70.4	70.4
6-7	70.4	70.4

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 7.50 ug Pb/dL

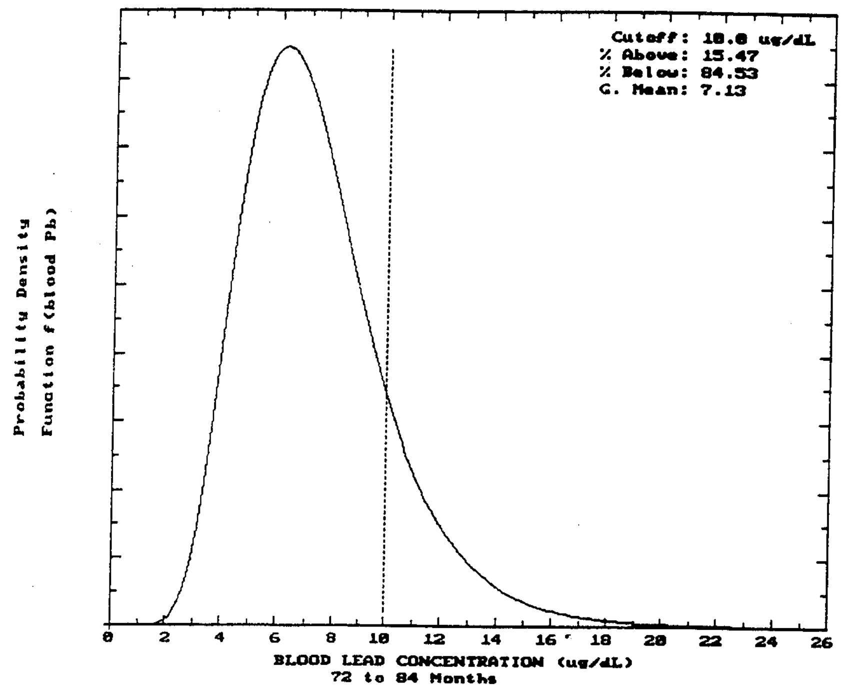
Figure H-7 (continued)

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
------	-----------	------------	------------
0.5-1:	3.84	11.26	1.80
1-2:	5.47	22.11	2.85
2-3:	6.37	23.20	2.85
3-4:	6.68	23.42	2.85
4-5:	6.95	23.22	2.11
5-6:	7.06	24.19	1.90
6-7:	7.13	24.77	1.80

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
------	-----------	------------	------------	---------
0.5-1:	2.94	6.52	0.00	0.00
1-2:	2.96	16.30	0.00	0.00
2-3:	3.40	16.95	0.00	0.00
3-4:	3.29	17.28	0.00	0.00
4-5:	3.18	17.93	0.00	0.00
5-6:	3.38	18.91	0.00	0.00
6-7:	3.74	19.23	0.00	0.00

Figure H-8. LEAD 0.6 Uptake/Biokinetic Model Results: Background (total lead concentration in groundwater) 178th Tactical Fighter Group, Springfield-Beckley Municipal Airport, Springfield, Ohio



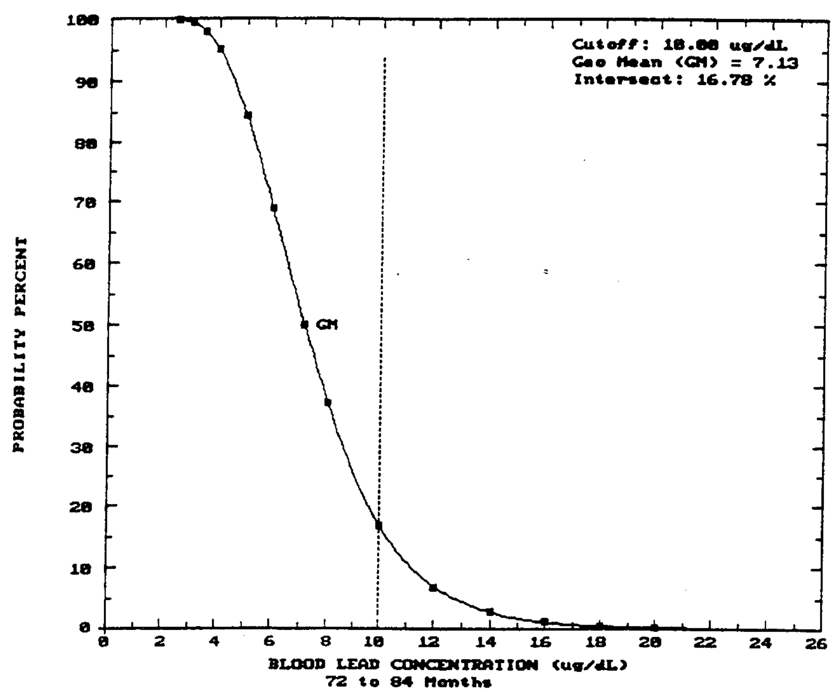


Figure H-9. LEAD 0.6 Uptake/Biokinetic Model Results: Background (dissolved lead concentration in groundwater) 178th Tactical Fighter Group, Springfield-Beckley Municipal Airport, Springfield, Ohio

ABSORPTION METHODOLOGY: Non-Linear Active-Passive

AIR CONCENTRATION: 0.000 ug Pb/m3
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 5.70 ug Pb/L
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	70.4	70.4
1-2	70.4	70.4
2-3	70.4	70.4
3-4	70.4	70.4
4-5	70.4	70.4
5-6	70.4	70.4
6-7	70.4	70.4

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 7.50 ug Pb/dL

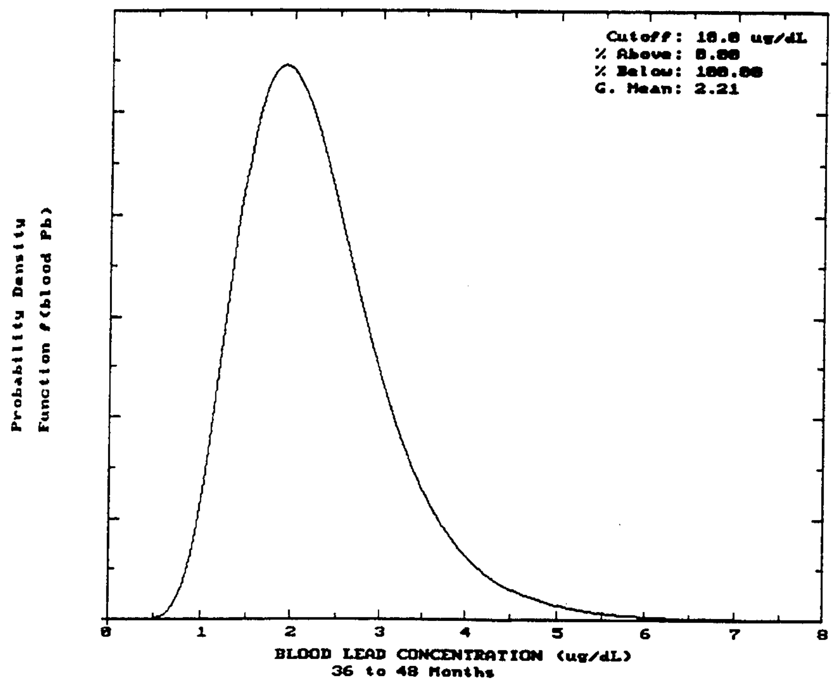
Figure H-9 (continued)

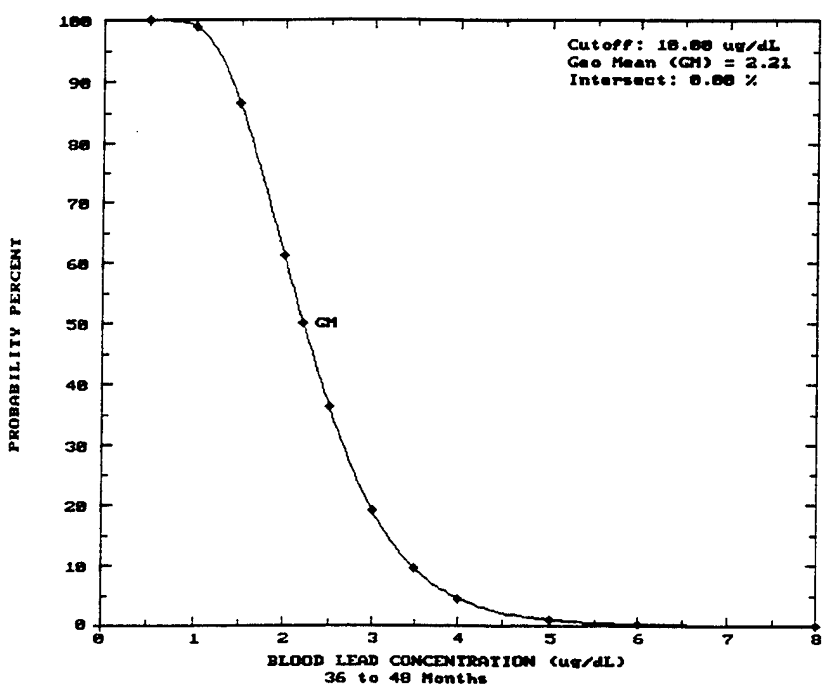
CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
------	-----------	------------	------------
0.5-1:	2.13	5.31	1.80
1-2:	2.05	7.24	2.85
2-3:	2.15	7.73	2.85
3-4:	2.21	7.65	2.85
4-5:	2.17	6.86	2.11
5-6:	2.08	6.93	1.90
6-7:	2.08	7.22	1.80

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
------	-----------	------------	------------	--------
0.5-1:	2.94	0.57	0.00	0.00
1-2:	2.96	1.43	0.00	0.00
2-3:	3.40	1.48	0.00	0.00
3-4:	3.29	1.51	0.00	0.00
4-5:	3.18	1.57	0.00	0.00
5-6:	3.38	1.65	0.00	0.00
6-7:	3.74	1.68	0.00	0.00

Figure H-10. LEAD 0.6 Uptake/Biokinetic Model Results:
Background (dissolved lead concentration in groundwater)
178th Tactical Fighter Group,
Springfield-Beckley Municipal Airport, Springfield, Ohio





APPENDIX I

Standard Operating Procedures

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

STANDARD OPERATING PROCEDURES

Submitted to:

Air National Guard Bureau
Andrews Air Force Base, Maryland 20331

Submitted by:

Hazardous Waste Remedial Actions Program
Martin Marietta Energy Systems, Inc.
Oak Ridge, Tennessee 37831

For the:

U.S. Department of Energy
Under Contract No. DE-AC05-840R21400

Prepared by:

Science Applications International Corporation
1710 Goodridge Drive
McLean, Virginia 22102

SAIC Project No. 1-827-03-200-02

May 1992

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FIELD PROCEDURE FP 1-1

MOBILIZATION AND DEMOBILIZATION FOR FIELD ACTIVITIES

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Subject	Procedure No.	Rev.	
	FP 1-1	0	Page 1 of 4
	Issue Date		Effective Date
MOBILIZATION AND DEMOBILIZATION FOR FIELD ACTIVITIES	05/25/90		07/02/90
	Supersedes Procedure Number	Rev.	Date
	630 FP 34	0	
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to outline the activities associated with mobilization and demobilization activities for field investigations.

2.0 SCOPE

2.1 This procedure applies to all field investigation activities commencing with the notice to proceed and ending with the completion of all field activities.

2.2 It is neither the intent of this procedure to fully detail all actions required for mobilization and demobilization nor define a specific methodology, but rather offer general points that should be considered in formulating a specific mobilization and demobilization plan. Mobilization and demobilization activities are specific to the planned field activities.

3.0 REQUIREMENTS

In order to efficiently implement a field investigation, specific tasks must be accomplished in an orderly fashion prior to actual field work (mobilization) and after field work has been completed (demobilization).

4.0 REFERENCES

4.1 HAZWRAP, November 1987, *Implementation Plan, Quality Assurance Requirements*, DOE/HWP-38

4.2 HAZWRAP, February 1989. *Quality Control Requirements for Field Methods*, DOE/HWP-69.

5.0 DEFINITIONS

None.

6.0 RESPONSIBILITIES

6.1 Project Manager

The Project Manager is responsible for compiling a list of required test and analytical equipment, tools for installation procedures, and ancillary supplies. It is necessary for him to locate sources and manufacturers of the test equipment, initiate purchase or lease agreements,

negotiate with the client for equipment purchases, and arrange laboratory space. He must make arrangements for special activities, i.e., transport and rigging of heavy and oversized equipment, etc.

6.2 Field Operations Leader

The Field Operations Leader is responsible for field purchase of equipment and tools, maintaining equipment logging, and ensuring adequate quantities of supplies. During demobilization, he must supervise packing of equipment for shipment, make arrangements for transport, and ensure all equipment and supplies are accounted for.

7.0 EQUIPMENT

None specified.

8.0 PROCEDURE

8.1 Mobilization

Mobilization is a process that begins with the Notice to Proceed and ends with the initiation of field activities. The time and effort that goes into a mobilization plan will be realized in an efficient and timely field investigation.

The many tasks to be considered include:

- Ordering and procuring items of a specialized nature or where a long lead time may effect the schedule. In many cases, the lead time may exceed the period between Notice to Proceed and initiation of work. It may be necessary to pre-order the item, on a risk basis, or re-schedule the initiation of work relative to the delivery of long-lead time items.

- Perform a thorough review of the business and cost proposal to determine if additional items may be needed. This should be discussed with the personnel assigned to field activities. If additional items are required, the client should be notified and depending on the contract type, changes initiated.

- Office and Work Space: If possible, survey the office area to determine furniture requirements: lighting and electrical requirements, especially if computers or specialized equipment must be operated; facilities such as water and restrooms; and storage areas for equipment and packing cartons.

- Personnel Assignments: Inform personnel of the date, location and activity required to be performed. Instruct personnel as to travel arrangements, motel stays, meal allowances, per diem, receipt requirements, etc. Provide administrative support such as copies of time sheets and expense reports so that these items are available at the field location.

- Locate sources for field purchased items and supplies: Establish accounts with firms that are able to supply a large percentage of the items required for field activities. This should be done with input from the Subcontract Administrator so that consideration can be given to small and/or disadvantaged businesses. While it may be possible to find a particular item at a lower cost by contacting many different sources, it is often more cost-effective to minimize the number of suppliers. A schedule for purchase of frequently used disposal items should also be established.

- Establish a system for reconciling payment of field-purchased equipment. This may include sending a copy of receipts to the home office and establishing and implementing a system of purchase order numbers by task.

- Establish an inventory system of disposal and non-disposable items to include a final disposition plan for all non-disposable items.

- Specific requirements should be detailed for mobilization of subcontractors to include drilling contractors, analytical laboratories and specialized field investigation companies. Activities to be considered include transportation, decontamination, orientation and badging, and initial set-up.

- Test and calibrate all equipment to ensure operational readiness.

- Perform a documented readiness review, prior to initiation of field activities. Risk management shall be applied wherein programmatic and technical elements of projects shall be assessed and preventive actions taken to ensure that the risk of achieving objectives is known and is acceptable. Potentially significant problems that could have a significant impact shall be identified and preventive action plans developed and implemented.

8.2 Demobilization

Demobilization includes all activities necessary to transfer all materials and suppliers after completion of field activities. Activities to be considered include:

- Special consideration should be given to the thorough completion of field activities before demobilizing. Preliminary demobilization efforts may be undertaken but all materials and supplies necessary for field activities should be retained until field activities are complete.

- A review of records and thorough inspection of equipment to ensure all equipment has been decontaminated.

- Special equipment, electronic equipment and other non-disposal items must be adequately packed and crated for shipment. A plan for transfer or storage of non-disposal items should be finalized.

- Remaining disposal items should be inventoried and packaged for transfer or storage.

- Field office files and field documentation should be inventoried and filing status verified before transfer to the home office. Many of these field documents will be necessary in writing reports of field activities.

9.0 ATTACHMENTS

None.

FIELD PROCEDURE FP 1-2

USE OF FIELD NOTEBOOKS

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Subject	Procedure No. FP 1-2	Rev. 0	Page 1 of 5
USE OF FIELD NOTEBOOKS	Issue Date 05/25/90		Effective Date 07/02/90
	Supersedes Procedure Number 630 FP 32	Rev. 0	Date
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to detail the minimum requirements for the proper generation and maintenance of logbooks used during the performance of a field investigation.

2.0 SCOPE

This procedure applies to the following logbooks when required to be maintained during the performance of a field investigation:

1. Site Logbook.
2. Field Operations Leader Logbook.
3. Health and Safety Logbook.
4. Field Equipment Logbook.
5. Decontamination Logbook.
6. Photographs.

3.0 REQUIREMENTS

Logbooks are initiated at the start of the first on-site activity (e.g., initial reconnaissance survey). Entries are .made each day that on-site activities take place which involve Engineering-Science (ES) or subcontractor personnel. A current logbook is maintained throughout the field effort for each activity.

The site logbook becomes part of the permanent project file. Because information contained in the site logbook may be admitted as evidence in cost recovery or other litigation, it is critical that this document be properly maintained.

4.0 REFERENCES

4.1 HAZWRAP, February 1989, *Quality Control Requirements for Field Methods*, DOE/HWP-69.

5.0 DEFINITIONS

Logbook - The logbook is a bound notebook with consecutively numbered pages that cannot be removed. Upon entry of data, the logbook requires signature by the responsible individual.

6.0 RESPONSIBILITIES

6.1 Project Manager

The site logbook is issued by the Project Manager to the Field Operations Leader or other person responsible for the direction of on-site activities (e.g., Reconnaissance Survey Team Leader, Sampling Team Leader). It is the responsibility of this person (or his designee) to keep the site logbook current while in his possession, and return it to the Project Manager or turn it over to another field team. Following the completion of all fieldwork, the site logbook is returned to the Project Manager for inclusion in the permanent project files.

6.2 Field Operations Leader

Field logbooks are issued by the Field Operations Leader to the person responsible for on-site activities. It is the responsibility of this person to keep the logbook current while in his possession and return it to the Field Operations Leader following completion of all fieldwork or when the logbook is full and a replacement logbook is needed.

7.0 EQUIPMENT

None specified.

8.0 PROCEDURE

8.1 General

The cover of each logbook will contain the following information:

- project name and HAZWRAP Work Assignment Number;
- project number;
- Project Manager's name;
- sequential book number;
- start date; and
- end date.

All entries should be made in black pen. No erasures are permitted. If an incorrect entry is made, the data should be crossed out with a single strike mark so as not to be obliterated and initialed and dated. At the completion of entries by any individual, the logbook must be signed at the bottom of every page.

8.2 Site Logbook

The site logbook is a controlled document which records all major on-site activities during a field investigation. At a minimum, the following activities or events should be recorded in the site logbook:

- arrival and departure of site visitors;
- arrival and departure of equipment;
- sample pick-up (e.g. chain-of-custody form numbers, carrier, time);
- sampling activities and sample logsheet numbers;
- start or completion of borehole, trench or monitoring well installation or sampling activities; and
- health and safety issues.

Daily entries into the logbook may contain a variety of information. At the beginning of each day the following information must be recorded:

- date;
- start time;
- weather;
- all field personnel present; and
- any visitors present.

During the day, a summary of all site activities and level of personal protection should be recorded in the logbook. The information need not duplicate that recorded in other field logbooks (e.g., sample logbook, Site Geologist's logbook, Health and Safety Officer's logbook, etc.), but should summarize the contents of these other logbooks and refer to the page locations in these logbooks for detailed information. An example of a site logbook page is shown in Attachment 9.1.

8.3 Field Operations Leader Logbook

The requirements for the field logbooks are the same as for the site logbook, except that the book is kept up to date in real time. In general, these books never leave the site and are sequentially numbered, if more than one are used. The front of the logbook lists the project number and name, the name of the contract under which the investigation is being conducted, and the date(s) of use. A field logbook is normally used by the rig geologist or by the Field Operations Leader to record specific details of each task. Although the field logbook

contains the specific field information being collected based on a task, the number of the field logbook and page numbers used for a particular day's performance will be referenced in the site logbook to include a brief summary.

8.4 Health and Safety Logbook

The Health and Safety logbook is used to document protection levels, health and safety training sessions and equipment meter readings that substantiate protection levels. The Health and Safety logbook is also used to document any abnormal occurrences or accidents. The Health and Safety Logbook is maintained by the Project Health and Safety Officer or his designee.

8.5 Field Equipment Logbook

The purpose of the field equipment logbook (FEL) is to document the proper use, maintenance, and calibration of field testing equipment. Before using field equipment, the Field Operations Leader (supervisor) shall inspect and approve the use of the field testing equipment by initialing the appropriate page in the FEL. A calibration record shall be maintained for each instrument used on-site and shall be kept in the FEL.

The following items shall be tracked in the FEL:

- equipment calibration status;
- equipment decontamination status;
- equipment nonconformance; and
- equipment inspection and repair records.

The person using, maintaining, or calibrating field equipment shall document his or her actions in the FEL. Entries shall contain the following:

- names and signatures of persons making entry;
- date of entry;
- name of equipment and its identifying number;
- list or reference of procedure(s) used for calibration or maintenance;
- manufacturer, lot number, and expiration date of calibration standards;

Entries in the log shall be signed and dated by the person(s) making the entry. Every page in the log will be signed and dated by the field supervisor. This signature reflects his or her review and approval of the entry validity.

8.6 Decontamination Logbook

The decontamination logbook is used to document the proper decontamination of equipment used in the field investigation. Equipment shall be documented as to type, serial number, and procedure reference or description of decontamination method utilized. Bulk items (e.g., well construction materials, soil gas probes, etc.) shall also be identified by date or

final destination for installation.

8.7 Photographs

The record of photographs taken at a site for the purpose of project documentation must be recorded in the site logbook or a field logbook. When movies, slides, or photographs are taken of a site or any monitoring location, they are numbered to correspond to logbook entries. The name of the photographer, date, time, site location, site description, and weather conditions are entered in the logbook as the photographs are taken. A series entry may be used for rapid-sequence photographs. The photographer is not required to record the aperture settings and shutter speeds for photographs taken within the normal automatic exposure range; however, special lenses, films, filters, and other image-enhancement techniques must be noted in the logbook. If possible, such techniques should be avoided, since they can adversely affect the admissibility of photographs as evidence. Chain-of-custody procedures depend upon the subject matter, type of film, and the processing it requires. Film used for aerial photography, confidential information, or criminal investigations require chain-of-custody procedures. Adequate logbook notations and receipts may be used to account for routine film processing. Once processed, the slides of photographic prints shall be serially numbered and labeled according to the logbook descriptions.

9.0 ATTACHMENTS

9.1 Typical Site Logbook Entry

TYPICAL SITE LOGBOOK ENTRY

START TIME: 08:00 **DATE:** 09 June 1990

SITE LEADER: ______________________________

PERSONNEL: ES **DRILLER** **EMR/OEPA**

____________	____________	____________
____________	____________	____________
____________	____________	____________
____________	____________	____________

WEATHER: Clear, 68°F, 2-5 mph wind from SE

ACTIVITIES:

1. Steam jenny and fire hoses were set up.
2. Drilling activities at well ____________ resumed. Rig geologist was ____________________. See Geologist's logbook, Not. 1, page 29-30, for details of drilling activity. Sample No. 123-21-S4 collected; see sample logbook, page 42. Drilling activities completed at 11:50 and a 4" stainless steel well installed. See Geologist's logbook, No. 1, page 31, and well construction details for well ____________.
3. Drilling Rig No. 2 steam-cleaned at decontamination pit. Then set up at location of well ____________.
4. Well ____________ drilled. Rig geologist was ____________________. See Geologist's logbook, No. 2, page _____ for details of drilling activities. Sample numbers 123-22-S1, 123-22-S2, and 123-22-S3 collected; see sample logbook, pages 43, 44, and 45.
5. Well ____________ was developed. Seven 55-gallon drums were filled in the flushing stage. The well was then pumped using the pitcher pump for one hour. At the end of the hour, water pumped from well was "sand-free".
6. OEPA arrives on-site at 14:25 hrs.
7. Large dump truck arrives at 14:45 and is steam-cleaned, Backhoe and dump truck set up over test pit ____________.
8. Test pit ____________ dug with cuttings placed in dump truck. Rig geologist was ____________________. See Geologist's logbook, No. 1, page 32, for details of test pit activities. Test pit subsequently filled. No samples taken for chemical analysis. Due to shallow ground-water table, filling in of test pit ____________ resulted in a very soft and wet area. A mound was developed and the area roped off.
9. Express carrier picked up samples (see Sample Logbook, pages 42 through 45) at 17:50 hrs. Site activities terminated at 18:22 hours. All personnel off-site, gate locked.

____

Field Operations Leader

FIELD PROCEDURE FP 1-3

SITE CLEAN-UP

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Subject	Procedure No. FP 1-3	Rev. 0	Page 1 of 2
SITE CLEAN-UP ACTIVITIES	Issue Date 05/25/90		Effective Date 07/02/90
	Supersedes Procedure Number 630 FP 17	Rev. 0	Date
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to detail responsibilities for site clean-up during and at completion of field investigation activities.

2.0 SCOPE

This procedure applies to test sites, approaches to test sites, decontamination areas, and equipment staging areas.

3.0 REQUIREMENTS

Each site, upon completion of field investigation activities, will be restored as closely as possible to its pre-investigation condition to the satisfaction of the Base point-of-contact.

4.0 REFERENCES

None.

5.0 DEFINITIONS

None.

6.0 RESPONSIBILITIES

The Field Operations Leader is responsible for planning and scheduling daily activities to include site clean-up. In addition, at the completion of field activities, the Field Operations Leader will assure that all areas are restored to pre-investigation conditions.

7.0 EQUIPMENT

None specified.

8.0 PROCEDURE

8.1 During drilling operations and at the end of each day, all trash and debris will be collected and disposed of in accordance with the site-specific work plan.

8.2 All potentially contaminated cuttings and affected soils will be placed in properly labeled, sealed openhead 55-gallon steel drums. These drums will be retained on-site until the

results of chemical analyses are obtained, if required. The cuttings will be disposed of in accordance with the site-specific work plan depending upon the results of the analytical data.

8.3 All non-contaminated soils will be placed on the ground and spread at the site.

8.4 Upon completion of field investigation activities, any damage, such as rutting, to the test site or adjacent areas, must be restored, as closely as possible, to its original condition by filling in, leveling, sodding, seeding and mulching.

8.5 As field activities are completed and areas restored, walkdowns of the area shall be scheduled with the client's representative. Areas shall be "cleared", i.e. no further action is required, or a punchlist of activities shall be developed and implemented. This process shall be repeated until all areas are "cleared".

8.6 Site clean-up and restoration activities should be included in the report of daily activities entered in the site logbook. No further documentation will be necessary.

9.0 ATTACHMENTS

None.

FIELD PROCEDURE FP 3-1

DECONTAMINATION OF SAMPLING EQUIPMENT

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Subject	Procedure No.	Rev.	
	FP 3-1	1	Page 1 of 6
DECONTAMINATION OF SAMPLING EQUIPMENT	Issue Date: 07/31/90		Effective Date: 08/06/90
	Supersedes Procedure Number: 630 FP 11	Rev.	Date
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to provide reference information on the proper decontamination of sampling equipment used to perform field investigations.

2.0 SCOPE

This procedure addresses decontamination of sampling equipment and should be consulted when equipment decontamination procedures are being developed as part of project-specific plans. Personnel decontamination guidelines are presented in the project-specific Health and Safety Plan. Decontamination of monitoring well construction materials is described in Field Procedure FP 3-2, and decontamination of hand tools and drilling equipment is described in Field Procedure FP 3-3.

3.0 REQUIREMENTS

To ensure that chemical analysis results are reflective of the actual concentrations present at sampling locations, equipment used in sampling activities must be properly cleaned and decontaminated. This will minimize the potential for cross-contamination between sampling locations, and the transfer of contamination off-site.

4.0 REFERENCES

4.1 HAZWRAP, February 1989, *Quality Control Requirements for Field Methods*, DOE/HWP-69.

4.2 United States Environmental Protection Agency. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987.

4.3 United States Environmental Protection Agency. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, EPA SW-846, Third Edition, November 1986.

5.0 DEFINITIONS

Negative Contamination - Occurs when the measured concentration of the analyte is artificially low as a result of volatilization, adsorption and related losses.

Positive Contamination - Occurs when the measured concentration of the analyte is artificially high due to leaching or the introduction of foreign matter into the sample.

Cross-Contamination - A type of positive contamination caused by the introduction of part of one sample with a second sample during sampling or storage.

Detergent - Shall be a standard brand of non-phosphate laboratory grade detergent such as Alconox or Liquinox.

Acid Solution - A combination of reagent-grade acid and deionized water.

Solvent - Shall be pesticide-grade solvent.

Tap or Potable Water - Shall be water from a municipal water treatment system.

Deionized Water - Volatile-free, ion-free, and organic-free water produced on-site from a deionization chamber equipped with carbon filters.

6.0 RESPONSIBILITIES

6.1 Project Manager

The Project Manager is responsible for ensuring that decontamination procedures for all chemical sampling and field analytical equipment are programmed prior to the actual field effort and that personnel required to accomplish the task have been briefed and trained to execute the task.

6.2 Field Operations Leader

The Field Operations Leader is responsible for ensuring that project-specific plans and the implementation of field investigations are in compliance with this procedure.

7.0 EQUIPMENT

7.1 Disposable gloves

7.2 Laboratory-grade non-phosphate detergent

7.3 Tap water

7.4 Ten percent nitric acid solution

7.5 Deionized volatile-free water

7.6 Aluminum foil

7.7 Pesticide-grade methanol

7.8 Pesticide-grade Hexane

7.9 Scrub brushes

7.10 Five to 10 gallon stainless steel or plastic buckets

8.0 PROCEDURE

8.1 Decontamination

Prior to the collection of samples, the equipment used to collect water, soil, sediment and other samples will be decontaminated by one of the following methods.

Method 1

Decontamination procedure for equipment used to collect metal samples only:

- Wash and scrub with laboratory-grade non-phosphate detergent.
- Rinse several times with tap water.
- Rinse plastic or Teflon-coated equipment with 10% nitric acid; rinse stainless steel equipment with 1% hydrochloric acid.
- Rinse twice with deionized analyte-free water.
- Air dry.
- Wrap in aluminum foil (shiny side out) or polyethylene sheeting.

Method 2

Decontamination procedure for equipment used to collect organic samples only:

- Wash and scrub with laboratory grade non-phosphate detergent.
- Rinse several times with tap water.
- Rinse with deionized analyte-free water.
- Rinse with pesticide-grade methanol.
- If total petroleum hydrocarbons, oil & grease, or PCBs are analytes, rinse with pesticide-grade hexane.
- Air dry.
- Check with HNu or OVA for complete removal of solvents.
- Wrap in aluminum foil (shiny side out).

Method 3

Decontamination procedure for equipment used to collect samples for both organics and metals analyses:

- Wash and scrub with laboratory-grade non-phosphate detergent.
- Rinse several times with tap water.

- Rinse plastic or Teflon-coated equipment with 10% nitric acid; rinse stainless steel equipment with 1% hydrochloric acid.
- Rinse with deionized analyte-free water.
- Rinse with pesticide-grade methanol.
- If total petroleum hydrocarbons, oil & grease, or PCBs are analytes, rinse with pesticide-grade hexane.
- Air dry.
- Check with HNU or OVA for complete removal of solvents.
- Rinse twice with deionized analyte-free water.
- Wrap in aluminum foil (shiny side out).

NOTE 1: Sampling Equipment Decontamination Procedures. Sampling equipment, other than down-hole sampling equipment, will be cleaned once a day in a batch so that the final rinsate may be collected for a field equipment blank. After cleaning, field equipment may be placed temporarily on polyethylene sheeting, but ultimately will be wrapped in aluminum foil. Care will be taken when choosing the site of the staging area to avoid fugitive dust, fuel, oils, gasoline, organic solvents, or any potential airborne source of contamination. If new equipment, such as drill bits and spoons, has been painted at the factory, this paint will be removed before use.

Down-hole sampling equipment may be decontaminated on-site during drilling activities. The sampling method used will determine where this sampling equipment will be decontaminated.

NOTE 2: Disposal of all wastes generated during the field activities is described in the project-specific Work Plan.

8.2 Requirements and Limitations

Bailers and Bailing Line

The potential for cross contamination between sampling points via the use of a common bailer, or its attached line, is high unless strict procedures for decontamination are followed. It is recommended that one bailer and its associated line be used for each sample point. Braided nylon or polypropylene lines may be used with a bailer and will be discarded after each use. Before the initial sampling and after each succeeding sampling point, the bailer must be decontaminated using procedures outlined for sampling equipment. This procedure does not eliminate the need for decontamination of dedicated bailers.

In addition to these cleaning procedures, the following line and bailer handling procedures are required. Prior to transport, the bailer and bailing line should be wrapped in

aluminum foil or polyethylene sheeting. At the site, while the sample(s) is being obtained, care should be taken to prevent the bailer, line, and any other down-hole tubing or pumps from contact with the ground surface.

Sampling Pumps

Most sampling pumps are normally low volume (less than two gpm) pumps. These include peristaltic, diaphragm, air-lift, pitcher and bladder pumps. If these pumps are used for sampling from more than one sampling point, they must be decontaminated between samples.

The procedures to be used for decontamination of sampling pumps are generally the same as those described in Method 2. Each of the liquid fractions is to be pumped through the system. The amount of pumping is dependent upon the size of the pump and the length of the intake and discharge hoses.

Filtering Equipment

One aspect of the sampling plan may involve the filtering of ground-water samples and subsequent preservation. This should occur as soon after sample retrieval as possible; preferably in the field as soon as the sample is obtained. Three basic filtration systems are most commonly used: the in-line disposal filter, the inert gas over-pressure filtration system, and the vacuum filtration system.

For the in-line filter, decontamination is not required since the filter cartridge is disposable; however, the cartridge must be disposed of in an approved receptacle, and the intake and discharge lines must still be decontaminated.

For the over-pressure and vacuum filtration systems, the portions of the apparatus which come in contact with the sample must be decontaminated as described above.

Water Level Indicators

Water level indicators that consist of a probe that contacts with the ground water must be decontaminated using the following steps:

1. Rinse with deionized volatile-free water.
2. Pesticide-grade methanol rinse followed by a pesticide-grade hexane rinse if oils, greases or PCBs are present.
3. Check with HNu or OVA for complete removal of solvents.
4. Wrap tip in aluminum foil (shiny-side out) for transport.

Probes

Probes (e.g., pH or specific ion electrodes, geophysical probes, or thermometers) that come in direct contact with the sample, will be decontaminated using the procedures specified above unless manufacturers' instructions indicate otherwise; in those cases, the method of decontamination must be clearly described in the project-specific Work Plan. For probes which make no direct contact (e.g., OVA equipment) the probe will be wiped with a clean paper-towel or cloth wetted with methanol.

8.3 Quality Control Procedures for Decontamination

The effectiveness of field cleaning procedures shall be monitored by following Quality Assurance - Quality Control procedures outlined in the project-specific Work Plan.

9.0 ATTACHMENTS

None.

FIELD PROCEDURE FP 3-2

DECONTAMINATION OF MONITORING WELL CONSTRUCTION MATERIAL

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Subject	Procedure No.	Rev.	
	FP 3-2	0	Page 1 of 4
DECONTAMINATION OF MONITORING WELL CONSTRUCTION MATERIAL	Issue Date		Effective Date
	05/25/90		07/02/90
	Supersedes Procedure Number	Rev.	Date
	630 FP 19	0	
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to provide reference information on the proper decontamination of monitoring well construction materials used in performing field investigations.

2.0 SCOPE

This procedure addresses decontamination of monitoring well construction materials only, and should be consulted when equipment decontamination procedures are being developed as part of project-specific work plans. Personal decontamination guidelines are present in the project-specific Health and Safety Plan. Decontamination of sampling equipment is described in Field Procedure FP 3-1 and decontamination of hand tools and drilling equipment is described in Field Procedure FP 3-3.

3.0 REQUIREMENTS

To ensure that chemical analysis results are reflective of the actual concentrations present at sampling locations, monitoring well construction materials involved in sampling activities must be properly cleaned and decontaminated. This will minimize the potential for cross-contamination between sampling locations, and the transfer of contamination off-site.

4.0 REFERENCES

4.1 HAZWRAP, February 1989, *Quality Control Requirements for Field Methods*, DOE/HWP-69.

4.2 United States Environmental Protection Agency. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987.

4.3 United States Environmental Protection Agency. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, EPA SW-846, Third Edition, November 1986.

5.0 DEFINITIONS

Negative Contamination - Occurs when the measured concentration of the analyte is artificially reduced as a result of volatilization, adsorption and related losses.

Positive Contamination - Occurs when the measured concentration of the analyte is artificially high due to leaching or the introduction of foreign matter into the sample.

Cross Contamination - A type of positive contamination caused by the introduction of part of one sample with a second sample during sampling or storage.

Detergent - Shall be a standard brand of non-phosphate laboratory-grade detergent such as Alconox or Liquinox.

Acid Solution - Shall be made from reagent-grade acid and deionized volatile-free water.

Solvent - Shall be pesticide-grade solvent.

Tap or Potable Water - Shall be water from a municipal water treatment system.

6.0 RESPONSIBILITIES

6.1 Project Manager

The Project Manager is responsible for ensuring that decontamination procedures for all chemical sampling and field analytical equipment are programmed prior to the actual field effort and that personnel required to accomplish the task have been briefed and trained to execute the task.

6.2 Field Operations Leader

The Field Operations Leader is responsible for ensuring that project-specific plans and the implementation of field investigations are in compliance with this procedure.

7.0 EQUIPMENT

1. Portable high-pressure steam or hot water generator
2. Insulated gloves
3. Laboratory-grade, non-phosphate detergent
4. Tap water
5. ASTM type II water
6. Sheet plastic
7. Pesticide-grade methanol
8. Scrub brushes
9. Five- to 10-gallon bucket

8.0 PROCEDURE

8.1 Construction Materials Decontamination

Prior to drilling, monitoring well construction materials will be decontaminated at a designated area. The cleaning area will be designed to contain decontamination wastes and waste waters, and can be a lined excavated pit or a bermed concrete or asphalt pad. For the latter, a floor drain must be provided that is connected to a holding tank. A shallow, above-surface tank may be used, or a pumping system with discharge to a waste tank may be installed.

At certain sites, due to the type of contaminants or proximity to residences, concerns may exist about air emissions from steam cleaning operations. These concerns can be alleviated by utilizing one or more of the following practices:

- Locate the steam cleaning area on-site to minimize potential impacts.
- Enclose steam cleaning operations.

The location of the steam cleaning area will be identified in the project-specific Work Plan.

Well casings and screens shall be cleaned in the field prior to use or shall be delivered to the site previously decontaminated with accompanying written certification by the factory or manufacturer attesting to decontamination procedures. Factory rinsate test results for parameters selected for each site shall be included. Field rinsate may be tested by field screening methods if available at the site. Critical contamination levels shall be determined prior to field work by the Project Manager and stated in the project-specific Work Plan.

Concentration levels above those previously determined as critical levels will require field steam cleaning of casings and screens. Analyses to be conducted, acceptable concentration levels for rinsates and specific rinsate sampling procedures shall be described in the project-specific Work Plan for each site.

8.2 Additional Cleaning Method

If critical levels are still not met, the following methods shall be utilized.

1. Wash and scrub with detergent (low phosphate if P is an analyte).
2. Tap water rinse.
3. Rinse with 10 percent nitric acid for PVC casing or a 1 percent HCL acid if stainless steel casing is used.
4. Tap water rinse.

5. Rinse with a methanol followed by hexane if oils, greases or PCBs are analytes.

6. Deionized water rinse (demonstrated analyte free).

7. Allow to air dry.

8. Wrap in aluminum foil, shine side out, for transport.

If metals are not analytes, Steps "3" and "4" may be omitted. If organics are not being sampled, Step "5" may be omitted. Solvents must be specified as pesticide grade or better. Preferably, all decontamination of equipment should be performed prior to going into the field. If this is not possible, equipment must be cleaned and decontaminated not less than six hours before installation.

9.0 ATTACHMENTS

None.

FIELD PROCEDURE FP 3-3

DECONTAMINATION OF HAND TOOLS AND DRILLING EQUIPMENT

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Subject	Procedure No.	Rev.	
	FP 3-3	0	Page 1 of 4
DECONTAMINATION OF HAND TOOLS AND DRILLING EQUIPMENT	Issue Date		Effective Date
	05/25/90		07/02/90
	Supersedes Procedure Number	Rev.	Date
	630 FP 20	0	
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to provide reference information on the proper decontamination of drilling equipment and hand tools used in the conduct of field investigations.

2.0 SCOPE

This procedure addresses decontamination of drilling equipment and hand tools only, and should be consulted when equipment decontamination procedures are being developed as part of project-specific work plans. Personal decontamination guidelines are present in the project-specific Health and Safety Plan. Decontamination of sampling equipment is described in Field Procedure FP 3-1 and decontamination of monitoring well construction materials is described in Field Procedure FP 3-2.

3.0 REQUIREMENTS

To ensure that chemical analysis results are reflective of the actual concentrations present at sampling locations, various drilling equipment and hand tools used in sampling activities must be properly cleaned and decontaminated. This will minimize the potential for cross-contamination between sampling locations, and the transfer of contamination off-site.

4.0 REFERENCES

4.1 HAZWRAP, February 1989, *Quality Control Requirements for Field Methods*, DOE/HWP-69.

4.2 United States Environmental Protection Agency, December 1987, *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001,.

4.3 United States Environmental Protection Agency, November 1986, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, EPA SW-846, Third Edition.

5.0 DEFINITIONS

Negative Contamination - Occurs when the measured concentration of the analyte is artificially reduced as a result of volatilization, adsorption and related losses.

Positive Contamination - Occurs when the measured concentration of the analyte is artificially high due to leaching or the introduction of foreign matter into the sample.

Cross-Contamination - Is a type of positive contamination caused by the introduction of part of one sample into a second sample during sampling or storage.

Detergent - Shall be a standard brand of non-phosphate laboratory-grade detergent such as Alconox or Liquinox.

Acid Solution - Shall be made from reagent-grade acid and deionized water.

Solvent - Shall be pesticide-grade solvent.

Tap or Potable Water - Shall be water from a municipal water treatment system.

Deionized Analyte-free Water - Ion free-organic free water produced on-site from a Deionization Chamber equipped with a carbon filter.

6.0 RESPONSIBILITIES

6.1 Project Manager

The Project Manager is responsible for ensuring that decontamination procedures for all chemical sampling and field analytical equipment are established prior to the actual field effort and that personnel required to accomplish the task have been briefed and trained to execute the task.

6.2 Field Operations Leader

The Field Operations Leader is responsible for ensuring that project-specific plans and the implementation of field investigations are in compliance with this procedure.

7.0 EQUIPMENT

7.1 Portable high-pressure steam or hot water generator.

7.2 Insulated gloves.

7.3 Laboratory-grade non-phosphate detergent.

7.4 Tap water.

7.5 Deionized volatile-free water.

7.6 Sheet plastic.

7.7 Pesticide-grade methanol.

7.8 Scrub brushes.

7.9 Five- to 10-gallon bucket.

8.0 PROCEDURE

All drilling equipment involved in field sampling activities will be decontaminated prior to drilling, excavation and sampling activities. Such equipment includes drilling rings, backhoes, down-hole tools, augers, and hand tools.

8.1 Steam Cleaning

Prior to drilling or leaving the site, equipment not directly utilized for sampling, will be decontaminated at a designated area. This includes drilling rigs, augers, backhoes, hand tools and down-hole tools. The decontamination area will be designed to contain decontamination wastes and waste waters, and can be a lined excavated pit or a bermed concrete or asphalt pad. For the latter, a floor drain must be provided that is connected to a holding tank. A shallow, above-surface tank may be used or a pumping system with discharge to a waste tank may be installed.

At certain sites, due to the type of contaminants or proximity to residences, concerns may exist about air emissions from steam cleaning operations. These concerns can be alleviated by utilizing one or both of the following practices:

- Locate the steam cleaning area on-site to minimize potential impacts.
- Enclose steam cleaning operations.

The location of the decontamination area will be identified in the project-specific Work Plan. Transport vehicles used on-site for personnel and/or equipment will be cleaned prior to leaving the site. Decontamination wastes will be collected and contained for eventual treatment on-site and/or disposal at an approved facility in accordance with the project-specific Work Plan.

8.2 Equipment Decontamination

Decontamination of equipment associated with sampling that will not come into contact with the sample medium.

- clean with high-pressure steam or hot water cleaner;
- wash with potable water and a non-phosphate laboratory-grade detergent; and
- rinse with potable water.

The drill rig, drill pipe, and all down-hole equipment will steam cleaned prior to entering the site and will be decontaminated in accordance with these procedures before work

is begun. Prior to use on each site, the rig will be decontaminated as described. All down-hole equipment will be decontaminated between each borehole.

9.0 ATTACHMENTS

None.

FIELD PROCEDURE FP 5-1

MONITORING OF HOLLOW STEM AUGER DRILLING ACTIVITIES

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Subject	Procedure No. FP 5-1	Rev. 0	Page 1 of 4
MONITORING OF HOLLOW STEM AUGER DRILLING ACTIVITIES	Issue Date 05/25/90		Effective Date 07/02/90
	Supersedes Procedure Number 630 FP 23	Rev. 0	Date
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to describe the methods and sequence of operations for recording field observations pertinent to the documentation of drilling activities.

2.0 SCOPE

This procedure applies to hollow stem auger drilling activities used to install monitoring wells, and drilling activities to determine the type, thickness, and certain physical and chemical properties of the soil, water, and rock strata which underlie the site.

3.0 REQUIREMENTS

Complete documentation must be kept to ensure proper installation of monitoring wells, knowledge of geologic data, and contract compliance by the drilling subcontractor.

4.0 REFERENCES

4.1 HAZWRAP, February 1989, *Quality Control Requirements for Field Methods*, DOE/HWP-69.

4.2 U.S. Environmental Protection Agency. *Manual of Water Well Construction Practices*, Office of Water Supply, USEPA, Washington, D.C.

5.0 DEFINITIONS

5.1 Hollow stem auger drilling consists of screwing augers with an open center into the ground. Cuttings are brought to the surface by the rotating action of the auger. Samples can be taken using split-spoon or thin wall tube samples inserted through the hollow stem and driven into the substrata in advance of the auger.

6.0 RESPONSIBILITIES

6.1 Field Operations Leader

The Field Operations Leader is responsible for ensuring that field personnel have been trained in the use of this procedure, and for verifying that auger drilling activities are being performed in compliance with the project-specific work plan. He should also determine the disposal methods for products generated by drilling, such as drill cuttings and well

development water, as well as any specialized supplies or logistical support required for the drilling operations. These activities should be documented in the site logbook.

6.2 Field Geologist

The Field Geologist is responsible for monitoring drilling activities and documenting observations made during drilling in a bound field logbook. He will summarize these activities on the Daily Drilling Report (Attachment 9.1). The Field Geologist will also generate a detailed boring log for each test hole. This log shall include a description of materials, samples, method of sampling, blow counts, and other pertinent drilling and testing information that may be obtained during drilling in accordance with Field Procedure FP 7-3, *Borehole Logging*.

7.0 EQUIPMENT

7.1 Field logbook.

7.2 Drilling subcontract.

7.3 Daily Drilling Report Form (Attachment 9.1).

8.0 PROCEDURE

8.1 Prior to arriving at the site, the Field Geologist will confer with the Field Operations Leader regarding the pertinent aspects of the drilling contract related to daily drilling activities.

8.2 A field logbook will be kept by each Field Geologist and will be used to record at least the following information:

- Date
- Location
- Weather
- Drilling company
- Drill crew names and telephone numbers
- Descriptions of the material being drilled

The Field Geologist will record, at a minimum, the following observations:

- Start and stop time of all drilling activities, including:
  - mobilization;
  - drilling/reaming/augering

- sampling;
- drill rig decontamination;
- cementing;
- geophysical well logging; and
- any other relevant events.

- Footage for the above activities.
- Type and quantity of drilling equipment (especially auger flights and drill stems).
- Condition of drilling equipment; should ensure that it is clean and no leaks in the system that would input the boring or well.
- Problems causing delays during drilling activities.

8.3 A Daily Drilling Report (Attachment 9.1) will be completed at the conclusion of drilling activities for the day. This report is required to document work conducted by the subcontractor and will be filled out as follows:

- Assign unique number to form.
- Enter unique code assigned to the borehole in the upper right-hand corner of the form in the space provided for boring ID.
- Enter descriptive name of the project and the project number in the space provided.
- Enter current date in the space provided.
- Enter type of equipment used for drilling operation.
- Enter diameter of the borehole in the space provided.
- Enter names of the Field Operations Leader and Field Geologist monitoring the drilling in the space provided.
- Enter the name of the drilling company, the driller, and the driller's helper in the spaces provided.
- Check the box applicable to the activities accomplished during the day in the space provided for daily activities.
- Circle the method(s) used (drilled/augered/cored or reamed) for the type of work accomplished and enter the start and stop depths (below surface level) in the blanks provided in the section titled "Footage.

- Enter the size in inches of bit(s) used in the space provided.
- Describe the type(s) of sample taken and the method(s) used; enter the quantity either in feet, volume or number of samples logged in the space provided.
- Enter number of hours to the nearest tenth of an hour in the applicable box or boxes (stand-by time is normally a delay caused by the contractor or the client; down time is a delay caused by the drilling subcontractor) in the space provided; comments should include, as a minimum, the following:
  - reason and start and stop times for standby or down time;
  - explanation of "other" time;
  - explanation of large deviations from planned progress; and
  - clear, concise comments relevant to any justification of work stoppage.
- Enter amount of material actually used by the subcontractor; comments include any necessary explanations for the amount entered in the space provided.
- Have driller verify the identified activities and sign the form in the space provided; the driller receives a copy of the form daily.
- Enter the start and stop footage below the land surface in the space provided for well construction information.
- Enter casing material under "Casing Type"; enter "Casing Size" in inches (specify O.D. or I.D.); check "Drain Hole" and "Stamped ID", in the space provided for well casing information.
- Sign and date (Field Geologist) the form in the space provided for verification of activities.
- Payment for standby hours and well acceptance must be approved by the Field Operations Leader or his designee. Sign and date (Field Operations Leader) in the space provided. This signature is required for payment of standby hours and well approval.
- Distribute copies of the Daily Drilling Report to individuals designated by the Field Operations Leader.

9.0 ATTACHMENTS

9.1 Daily Drilling Report.

DAILY DRILLING REPORT

	DAILY DRILLING REPORT	Boring ID: ______

Project: ______ Date: ______

Drilling Method: ______ Borehole Diameter: ______

Supervisor/Geologist: ______ Driller: ______

Drilling Company: ______ Helper: ______

DAILY ACTIVITIES:

- ☐ Mobilization
- ☐ Decontamination
- ☐ Set-up
- ☐ Drilling/Augering/Coring
- ☐ E-logging (standby)
- ☐ Reaming
- ☐ Setting Surface Casing
- ☐ Well Installation
- ☐ Well Development
- ☐ Clean-up
- ☐ Std. Penetration Test
- ☐ Other: ______

Footage:

Drilled/Augered/Cored: ______ ft to ______ ft; Reamed: ______ ft to ______ ft

Bit Sizes: ______ ______

Sample Type: ______ Quantity: ______ S.P. Tests (qty): ______

Time: Drill/Rig: ______ hr. Well Development: ______ hr.

Decon.: ______ hr. Down Time: ______ hr.

Standby: ______ hr. Other: ______ hr.

Comments: ______

Material Used: Bentonite: ______ bags Bentonite: ______ buckets

Cement: ______ bags ______: ______

Sand: ______ bags Comments: ______

Verification of Activities: ______ Date: ______
(Driller Signature)

WELL CONSTRUCTION:

Screen Setting: ______ ft to ______ ft BLS

Blank Casing Setting: ______ ft to ______ ft BLS

Sand Pack Setting: ______ ft to ______ ft BLS

Seal Setting: ______ ft to ______ ft BLS

Grout Setting: ______ ft to ______ ft BLS

Surface Casing:

Casing Type: ______

Casing Size: ______

Drain Hole: ☐ Yes ☐ No

Stamped ID: ☐ Yes ☐ No

Comments: ______

Development Method(s): ______

Verification of Activities: ______ Date: ______
(Supervisory Geologist Signature)

Approved for Payment: ______ Standby Hours. Well Accepted: ☐ Yes ☐ No

______ Date: ______
(Field Supervisor Signature)

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FIELD PROCEDURE FP 5-2

MONITORING WELL INSTALLATION

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Subject	Procedure No. FP 5-2	Rev. 0	Page 1 of 10
MONITORING WELL INSTALLATION	Issue Date 05/25/90		Effective Date 07/02/90
	Supersedes Procedure Number 630 FP 28	Rev. 0	Date
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to establish acceptable methods for proper monitoring well design and construction.

2.0 SCOPE

This procedure is applicable to the construction of semi-permanent monitoring wells at field investigation sites. The methods described herein may be modified by project-specific requirements for monitoring well construction. In addition, many states have specific regulations pertaining to monitoring well construction and permitting. These requirements must be fully developed when preparing the project-specific work plan.

3.0 REQUIREMENTS

The objectives for each monitoring well and its intended use must be clearly defined before the monitoring system is constructed. Within the monitoring system, different monitoring wells may serve different purposes and, therefore, require different types of construction. During all phases of the well construction, attention must be given to clearly documenting the basis for construction decisions, the details of well construction, and the materials used.

Siting of monitoring wells shall be performed after a preliminary estimation of the hydraulic gradients and ground-water flow direction. In most cases, these can be determined through review of geologic data and the site terrain. In addition, production wells or other monitoring wells in the area may be used to determine the flow direction.

4.0 REFERENCES

4.1 Driscoll, Fletcher G. 1986. *Groundwater and Wells*, 2nd Edition, Johnson Division, St. Paul, Minnesota, pp. 1089.

4.2 HAZWRAP, February 1989, *Quality Control Requirements for Field Methods*, DOE/HWP-69.

5.0 DEFINITIONS

Monitoring Well - A well which will provide for the measurement of total well depth, the collection of representative groundwater samples, the detection and collection of representative light- and dense-phase organics, and measuring piezometric data.

6.0 RESPONSIBILITIES

6.1 Project Manager

The Project Manager is responsible for selecting the well casing and screen materials, the screen length and placement, and the filter pack and seal materials to be used for each monitoring well. The Project Manager should work in cooperation with the Field Operations Manager to ensure that all contract items are fulfilled and that the project is executed in a scientifically sound manner.

6.2 Field Operations Manager

The Field Operations Manager is responsible for ensuring that field personnel have been trained in the use of this procedure and for verifying that monitoring well installation activities are performed in compliance with the contract. The Field Operations Manager will obtain the information necessary for the Project Manager to select screen size and well packing material and siting well installation locations.

6.3 Field Geologist

The Field Geologist is responsible for ensuring the well is installed according to the contract specifications. If notification of the driller does not result in corrective action, the Field Geologist will thoroughly document the driller's failure to follow procedures and notify the Field Operations Manager as soon as possible.

7.0 EQUIPMENT

7.1 Field Logbook and Indelible Ink Pens

7.2 Monitoring Well Construction Log

7.3 Folding or Retractable Engineers Rule

7.4 Weighted Tape

7.5 Slot Size or Feeler Gauge.

8.0 PROCEDURE

8.1 Design Considerations

Monitoring Well Depth, Diameter and Screen Length

- Standard well diameters are two, four, six, or eight inches. For most monitoring programs a two or four-inch well is preferred. Smaller wells

have a smaller volume of stagnant water, well construction costs are lower, and the water table stabilizes readily.

- In specifying well diameter, sampling requirements must be considered. A total of up to four gallons or water may be required for a single sample to account for full organic and inorganic analyses and split samples. The standing water in the monitoring well available for sampling after complete recharge is dependent on the well diameter as follows:

Casing Inside Diameter, Inches	Standing Water Depth to Obtain One Gallon Water (ft)	Total Depth of Standing Water For Four Gallons (ft)
2	6.13	25
4	1.53	6
6	0.68	3

- The borehole diameter should be at least four inches larger than the well riser pipe diameter.
- Wells deeper than 35 feet must be at least four inches in diameter.

Riser Pipe and Screen Materials

- Schedule 40 PVC has sufficient tensile and compressive strength for wells up to 75 feet. Schedule 80 PVC is generally used for wells greater than 50 feet.
- The inside diameter for schedule 80 PVC is smaller and may be an important factor when considering the size of bailers or pumps to be used for the sampling. Due to this problem, the minimum well pipe size recommended for schedule 80 is four inches I.D.
- Steel screens and risers must be decontaminated before use according to FP 3-2.
- Galvanized steel is not recommended for metals analyses, as zinc and cadmium levels in ground water samples may be elevated from zinc coating.
- Type 316L stainless steel or other alloys should be considered for use in sulfidic waters.
- Threaded, flush joint casing is required. No glues are allowed.
- For deep wells the screen must be chosen to withstand the column weight without collapsing. The screen shall pass no more than 10 percent of pack material or in-situ aquifier material.
- The field geologist shall specify the combination of screen slot size and gravel pack gradation.

Annual Materials

Material placed in the annular space between the borehole and well-riser pipe includes a gravel pack when necessary, a bentonite seal, and cement grout. In general, all of these should be installed via a tremie pipe placed in the annular space. The so called "gravel pack" is usually a fine to medium grained uniform sand. The quantity of sand placed in the annular space is dependent upon the length of the screened interval but should always extend two to three feet above the top of the screen. At least two to three feet of bentonite pellets or granular bentonite shall be placed above the gravel pack.

Bentonite expands by absorbing water and provides a seal between the screened interval and the rest of the annular space and formation. Cement grout is placed on top of the bentonite to the surface. The grout effectively seals the well and eliminates the possibility of surface runoff reaching the screened interval. Grouting also replaces material removed during drilling and prevents hole collapse and subsidence around the well. A tremie pipe shall be used to introduce grout from the bottom of the hole upward, to prevent bridging and to provide a better seal. In some shallow holes, it may be more practical to pour the cement from the surface without a tremie line.

Grout is a general term which has several different connotations. For all practical purposes within the monitoring well installation industry, grout refers to the solidified material which is installed and occupies the annular space above the bentonite seal. Grout, most of the time, is made up of two assemblages of material, i.e., a cement-bentonite grout or a neat cement grout. A cement bentonite grout normally is a mixture of cement, bentonite and water at a ratio of one 90 pound bag of Portland Type I cement, three to five pounds of granular or flake-type bentonite and six gallons of water. Neat cement is made up of one 90 pound bag of Portland Type I cement and six gallons of water.

Protective Equipment

When the well is completed and grouted to the surface, protective steel casing is often placed over the top of the well. This casing generally has a hinged cap and can be locked to prevent vandalism. A vent hole shall be provided in the riser pipe just below the cap to allow venting of gases and maintain atmospheric pressure as water levels rise or fall in the well with the exception of wells installed to monitor gases. The protective casing has a larger diameter than the well and is set into the wet cement grout over the well upon completion. In addition, at least one one-fourth inch hole is drilled just above the cement collar through the protective casing which acts as a weep hole for the flow of water which may enter the annulus during well development, purging, or sampling.

Three three-inch diameter Schedule 40 steel guard posts filled with cement is usually placed around the protective steel riser pipe. The posts are generally eight feet in total length and installed approximately four feet into the ground with independent concrete footings.

Protective casing which is level with the finished surface is used in roadway or parking lot applications where the top of a monitoring well must be below the pavement. The top of the well is placed four to five inches below the pavement and cemented to approximately six or seven inches below the pavement. A protective sleeve is set into the wet cement around the well with the top set level with the pavement. A locking gasket cap is placed on the well to seal out water and a manhole type lid placed over the protective sleeve. The top of the well resembles a small manhole. If the cement grout seal is effective and does not leak, the hole below the pavement will hold water. A drainage system may be required to direct pooled water away from the well head.

8.2 Monitoring Well Construction

Predrilling Activities

Underground utility maps for the immediate vicinity of the drilling site will be reviewed and proposed drilling locations will be staked in the field for inspection. Digging permits will then be obtained. No drilling will be done without the required digging permits.

- Inspect the screen to insure that no damage has occurred during shipment and decontamination. Also record the type and class of material and screen slot size. Check the slot size with a feeler gauge to insure that the screens are properly labeled.

- Prior to placing well materials in the borehole place a 1 to 2 foot backfill of filter pack material below the base of the screen. The filter pack will consist of chemically inert (e.g. clean quartz sand, silica or glass beads) well rounded and dimensionally stable.

- Assemble the well casing and screen and place the material in the borehole. Attach centralizers as specified in the Project Work Plan to ensure that each well is straight as possible and centered in the borehole. A sump or sampling cup device 1 to 2 foot long may be attached to the bed of the well to aid in collecting fine-grained sediments and to capture dense minerals contaminants for analysis.

  NOTE: All well screen, riser pipe, sump, bottom plug and cap will be threaded and flush jointed. No glues or solvents are to be used in monitoring well installation.

- Record the depth of the base of the well, the top of the screen, and the screen length in the monitoring well construction log.

Placement of Filter Pack and Annular Seal

- Place the monitoring well filter pack by slowly pouring filter pack material directly or pumping a sand slurry through a tremie pipe into the annulus between the well screen and the open borehole wall. If the borehole will not stand open place filter pack material directly into the annulus between the auger wall and the well casing and screen. Then gradually pull back the auger string in small increments (2 feet at a time) to allow the sand to settle around the screen below the augers. Care will be taken to prevent filter pack material from bridging between the borehole wall or augers and the well screen and riser pipe.

NOTE: The filter pack material will be chemically inert (e.g., clean quartz sand, silica, or glass beads) with particles that are well-rounded. Fabric filters are not permitted.

- The filter pack material will be placed from the bottom of the well to a nominal two feet above the top of the screen. The depth to the top of the sand pack will be recorded. Note the number of bags of sand used.

- Tremie, or for shallow wells ($\leq$ 35 feet) gravity feed, bentonite pellets or chips (not powder) onto the top of the filter pack to form a 2 to 3 foot seal. Bentonite pellets must be used if the seal is to be seated below the water table. Granular, flake or slurried bentonite may be used above the water table. If a tremie pipe is used, slowly withdraw the pipe as the bentonite is added to ensure even placement around the annulus. Check the depth with a weighted tape.

- Follow manufacturer's specifications for hydration time. Record the depth to the top of the bentonite seal, the number of buckets/bags of bentonite used, and the amount of water added for hydration (if applicable) on the Monitoring Well Construction Log.

  NOTE: The annular seal material must be chemically compatible with the well materials and contaminants and chemically insert so it does not affect the quality of groundwater samples. The permeability of annular seals will be one to two orders of magnitude less than the surrounding formation.

- Tremie a neat cement-bentonite grout above the bentonite seal by pumping it through a tremie pipe (with its bottom opening set top of the well seal to prevent disturbance of the seal during pumping activities), and allow the grout to rise in the borehole annulus to the bottom of the frost line.

NOTE: Cement-bentonite grout typically consists of one 94-pound sack of Portland cement and 3 to 5 pounds of powdered bentonite with 6.5 of Portland cement and 3 to 5 pounds of powdered bentonite with 6.5 gallons of water. Mix the bentonite and water first, and then add the cement (Driscol 1986). Check the density with a mud balance to ensure proper mixture ratio.

- Place concrete from the frost line to the base of the well completion. ASTM Type II cement should be used where ground-water contains dissolved sulfates.

Above Ground Well Completion

- Notch the north side of the well casing with a hacksaw or file. The notch will be the point from which surveys and subsequent water level measurements will be measured. Ensure no filings or PVC shavings enter the well.

- For wells that are completed above the ground surface the finish casing should extend approximately 2-1/2 feet above the land surface with a protective steel riser pipe equipped with a hinged, loose-fitting cap that can be locked to prevent unauthorized entry. Sufficient space must be allowed between the protective casing lid and the top of the well riser pipe for a well cap. the minimum size for 2-inch well is 6-inch protective casing. The riser pipe should extend approximately 2 feet above the land surface.

- Construct a concrete pad around the protective casing within 24 hours of well installation. The pad shall slope away from the casing in all directions. Embed a brass surveyors pin in the concrete pad and stamp the well Identification Number and elevation of the top of the casing in the pin and on the top of the Protective Casing and the Inner Casing. The pad size shall be as stated in the project-specific work plan.

- Drill a 1/4 inch diameter weep hole into the side of the protective casing near the top of the concrete pad to permit drainage.

- Install three 3-inch diameter by 8-foot long, concrete-filled (schedule 40) steel guard posts radially around the concrete pad. The guard posts will extend approximately four feet into the ground with independent concrete footings.

Flush Mount Completions

For wells that are completed flush with the land surface, install a well vault over the well riser pipe. The vault will be water-tight and equipped with a locking mechanism to prevent unauthorized entry. A system for drainage also should be installed. For flush-mount completions, the top of the well is four to five inches below ground surface and concreted to at least six inches below ground surface.

Monitoring Well Installations in Confined Aquifers

1. Advance an oversized borehole through unconsolidated surface deposits to a depth of 2 to 3 ft into the top of the confining bed. In general, the borehole should be 2 in. in diameter larger than the casing to be installed when a tremie is to be used.

2. Condition the borehole by circulating air (or mud, if used) or by rotating augers without drilling until the hole is cleaned of cuttings.

3. While performing Step 2, make-up the necessary length(s) of surface casing. Surface casing may be of mild or galvanized steel.

4. Pressure grout bentonite pellets or chips to fill the portion of the borehole in the confining bed. If the bentonite seal is to be set below the static water level, only pellets may be used. The bentonite should hydrate in the presence of groundwater, but potable or distilled water may be added if needed.

5. Insert the surface casing into the borehole and push firmly into the bentonite seal in the confining bed.

6. Mix Portland cement with bentonite powder (as previously described) and water to make a pumpable slurry. Weigh the bentonite before mixing; the addition of more than 3 lbs of bentonite will severely reduce grout strength.

7. Insert the tremie pipe into the borehole and begin pumping grout. Slowly withdraw the tremie pipe as the annulus fills to ensure even placement with no bridging.

8. Allow grout to cure for 48 hours or longer before proceeding.

9. After grout has cured, rig up with a smaller diameter bit and proceed with drilling. Advance the borehole to the desired depth. The hole should be drilled a few feet deeper than necessary to allow for cave-ins during casing placement. If more than one aquifer will be encountered during drilling, the well must be cased in separate stages to prevent cross-contamination. Step 1 through 8 of this section should be followed for each separate aquifier that must be cased off.

10. Condition the borehole by circulation air (or mud, if used) until the hole is cleaned of cuttings. Pull the drill string out of the borehole when no additional cuttings reach the surface. Check the hole depth with a weighted surveyor's type.

11. Make up the casing string in manageable sections while conditioning the borehole. The casing and screen (if used) must be decontaminated in accordance with FP 3-2 before make-up. Tighten casing joints to the manufacturer's specifications.

12. Insert the first segment of the casing string and lower to a convenient height for adding the second casing segment. Chock the casing, add the second segment, then release the chock and lower the casing. Repeat this process until the full casing string is hanging in the well. Centralizers, beginning at the top of the screen, should be placed at 30 to 40 ft. intervals, according to the project-specific work plan. The casing string should be allowed to hang in the well rather than set on bottom. Casing

strings with Teflon screens should never be set on the bottom because the weight of casing will significantly reduce the slot size and may collapse the screen.

13. Insert the tremie to near the bottom of the screen and begin running the filter material through the tremie. Slowly withdraw the tremie so that the filter pack is placed evenly around the screen without bridging. One to two feet of filter pack material must be spotted at the bottom of the hole, under the screen. The filter pack must be installed to at least 2 to 3 ft. above the top of the screens. If the top of the screen is below the bottom of the confining layer, extend the filter pack to the confining layer, if appropriate. Develop the well according to FP 5-2 to settle the filter pack and, if used, remove slurry water.

14. If the filter pack was placed as a slurry, withdraw the tremie pipe, rinse with potable water, and dry before proceeding to add the bentonite seal. The potable rinsewater does not have to be contained. If the filter pack was installed dry, do not remove the tremie unless a larger diameter pipe is needed for installing the bentonite seal and grout. Check the depth of the filter pack to ensure that it rises above the top of the screen.

17. Tremie bentonite pellets or chips onto the top of the filter pack. Bentonite pellets must be used for installations below the water table. Granules, chips flakes, or slurries are suitable for use above the water table. Bentonite slurry or pellets must be used where the seal is installed below the water table. the bentonite seal must extend 2 to 3 ft. into the confining layer, if possible. Slowly withdraw the tremie pipe as bentonite is added to ensure even placement around the casing without bridging.

18. Hydrate the bentonite according to the manufacturer's specifications. Record amount of water used.

19. Mis Portland cement with powdered bentonite (as previously described) and water to make a pumpable slurry. Weigh the bentonite before mixing; addition of more than 3 lbs of bentonite will severely reduce grout strength.

20. Tremie the grout into the annulus. Slowly withdraw the tremie pipe as the annulus fills to ensure even placement. Grout the well to within 2 to 3 ft of the surface, but not above the average frost line.

21. After installing grout, dismantal and clean tremie equipment.

Monitoring Well Completion and Borehole Records

The Field Geologist will record the lithology and complete a drilling record for all single borings and the deepest borehole drilled at each multiple hole drilling location.

See Section 9.0 Attachments for specific well type. Borehole logging will be in accordance with FP 7-3.

9.0 ATTACHMENTS

9.1 Standard Monitoring Well Construction

9.2 Monitoring Well Construction When Water Table is Near Land Surface.

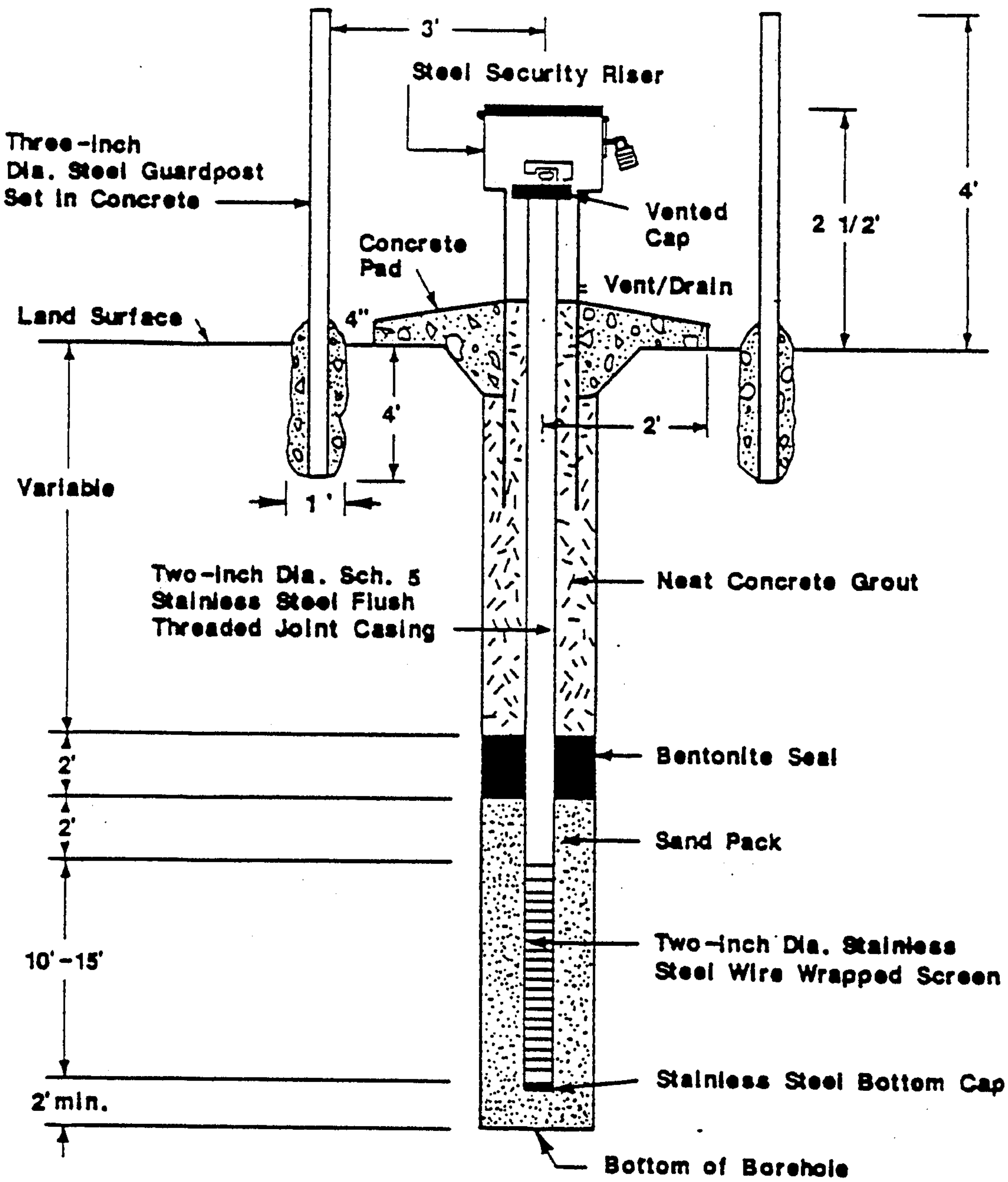
9.3 Monitoring Well Construction With Sealed Cap and Flush Surface Presentation.

9.4 Monitoring Well Construction With Telescoped Casing.

9.5 Monitoring Well Construction Logs:

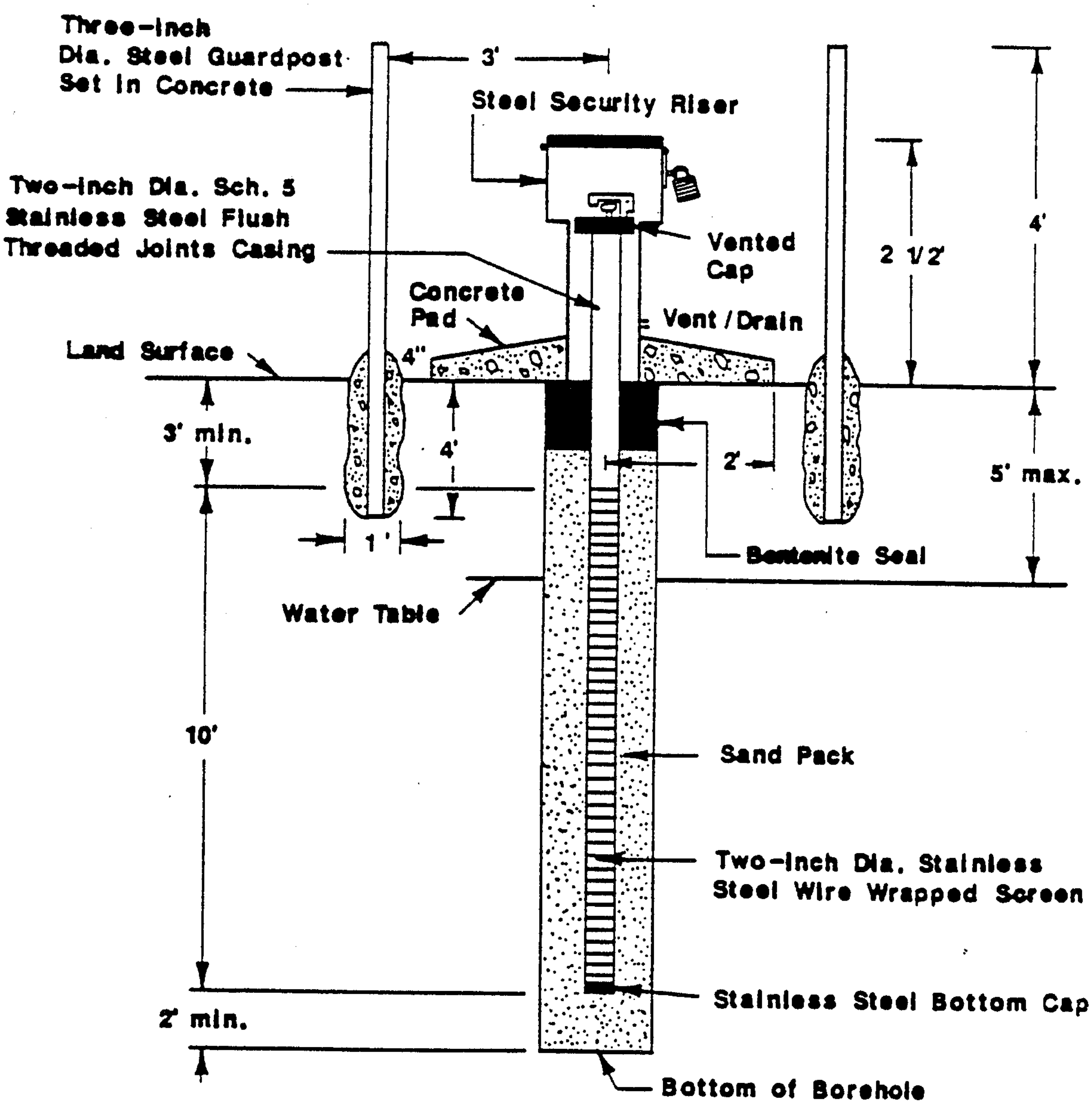
- Standard
- Standard Flush Mount
- Double Cased
- Double Cased Flush Mount
- Open Hole
- Open Hole Flush Mount

STANDARD MONITORING WELL CONSTRUCTION

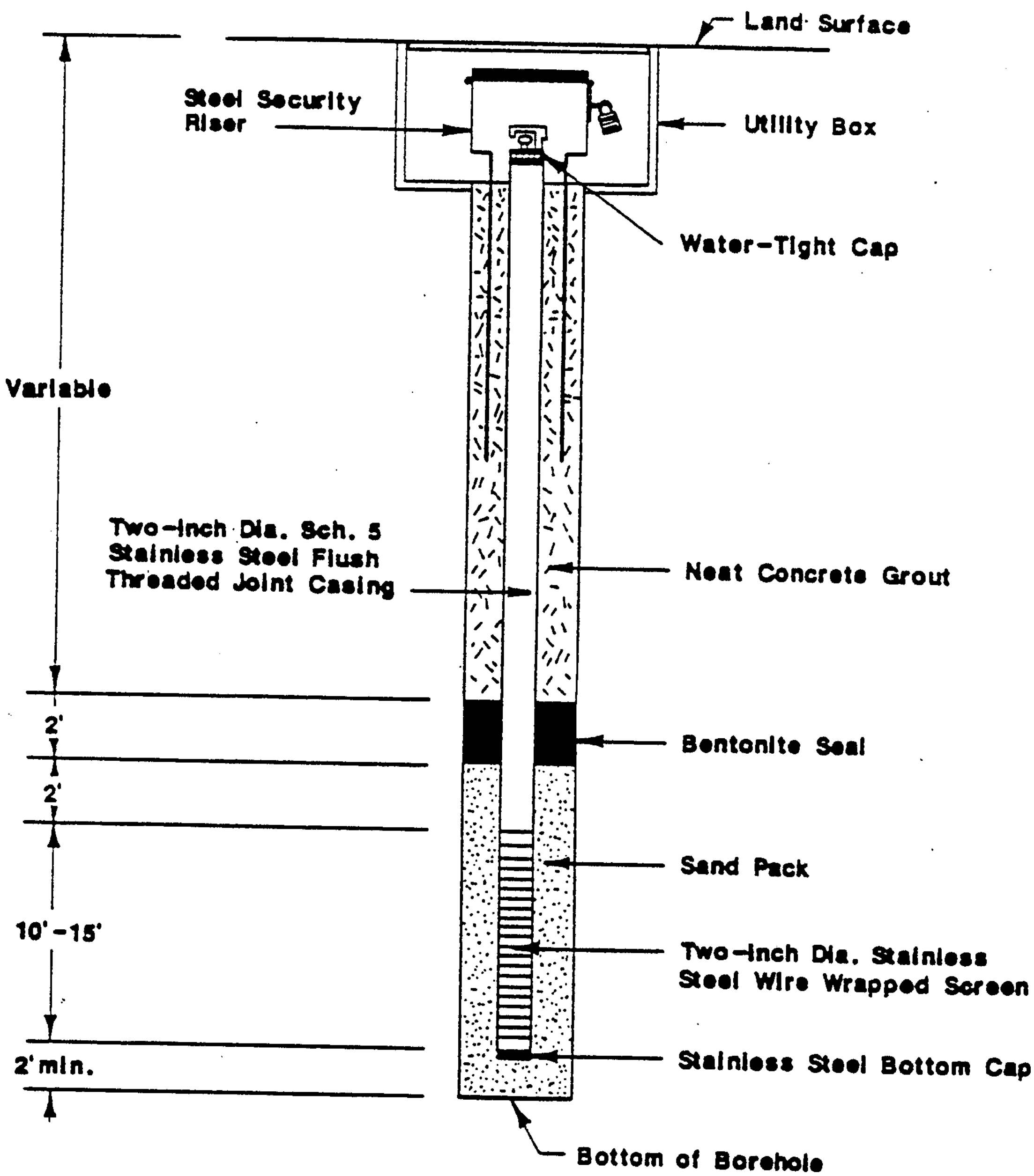


ATTACHMENT
FP 5-2

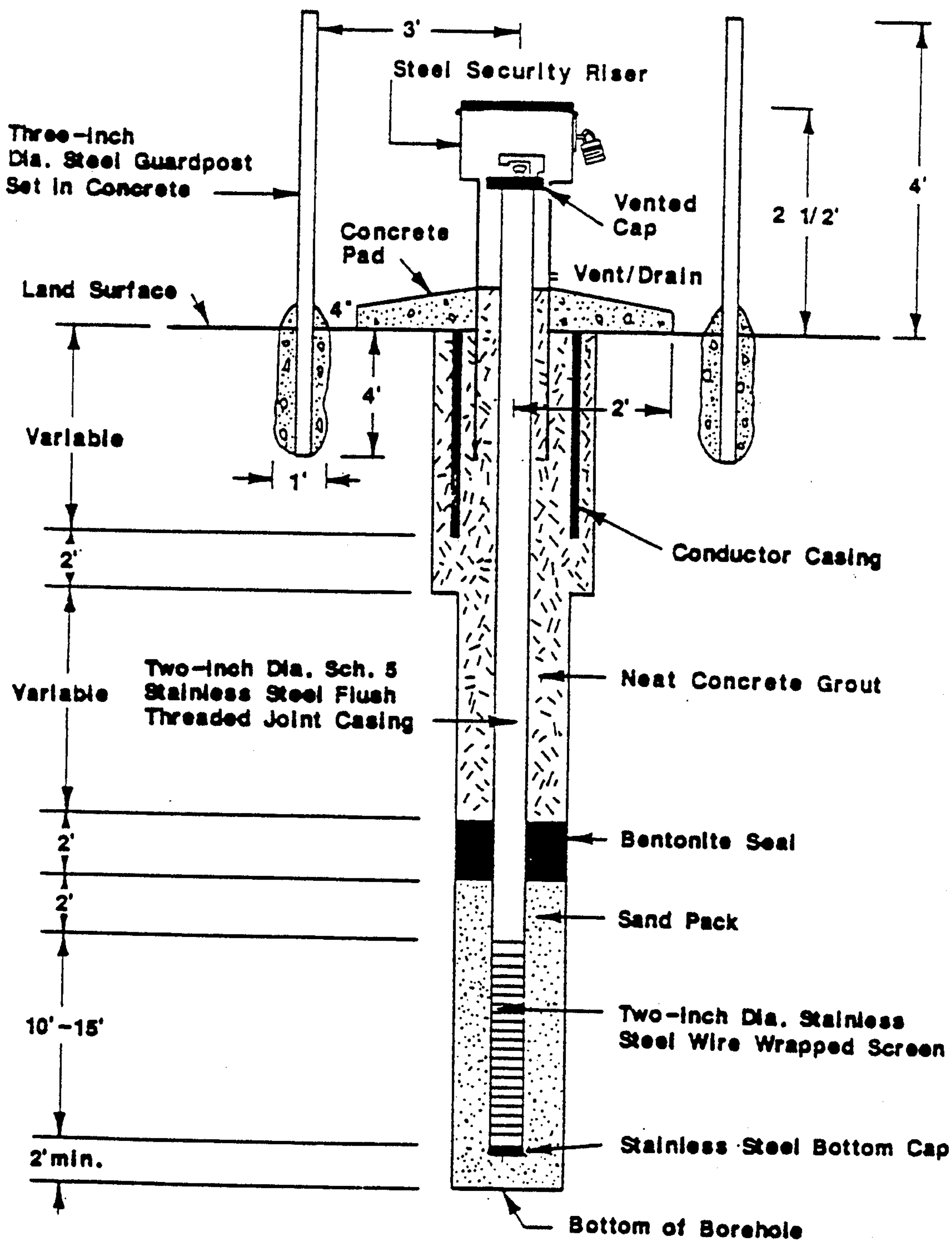
MONITORING WELL CONSTRUCTION WHEN WATER TABLE IS NEAR LAND SURFACE



MONITORING WELL CONSTRUCTION WITH SEALED CAP AND FLUSH SURFACE PRESENTATION



MONITORING WELL CONSTRUCTION WITH TELESCOPED CASING



ATTACHMENT 9.5
FP 5-2
7 Pages

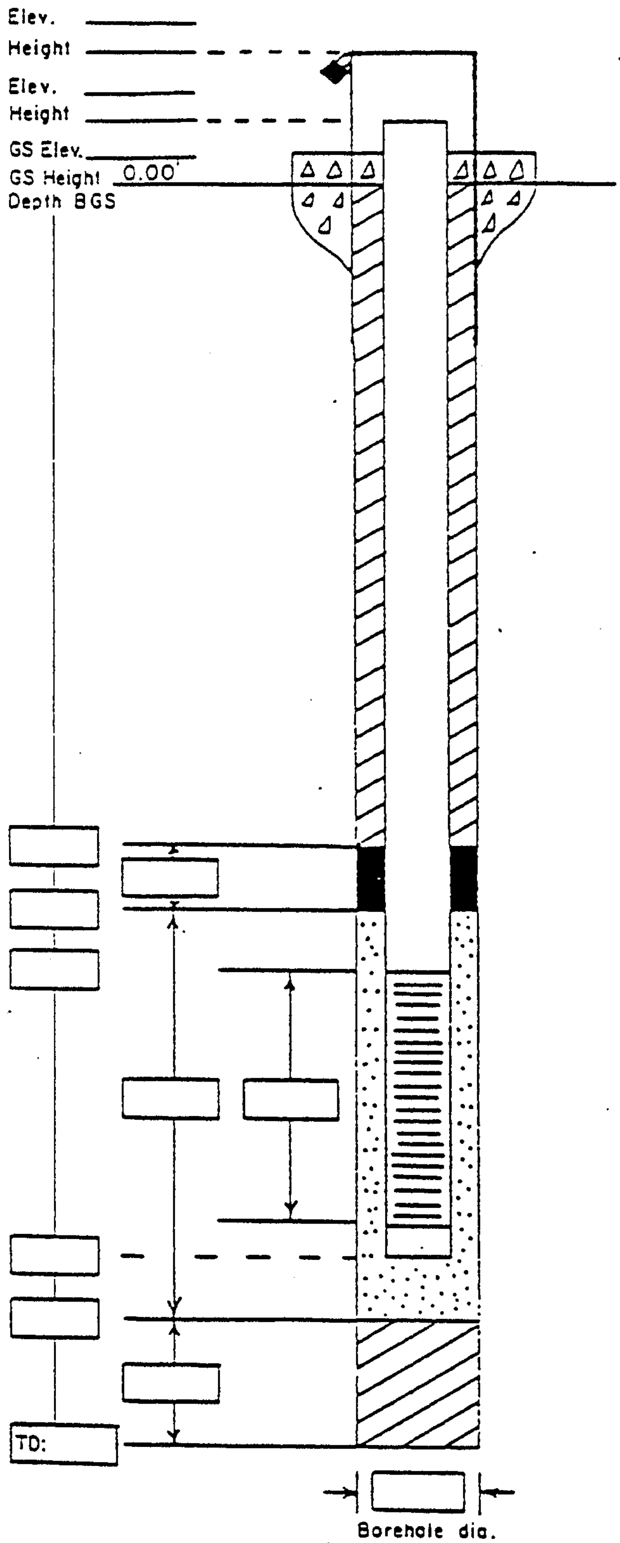
MONITORING WELL CONSTRUCTION LOGS

- Standard
- Standard Flush Mount
- Double Cased
- Double Cased FLush Mount
- Open Hole
- Open Hole Flush Mount

REV DATE: JAN 1989

MONITORING WELL CONSTRUCTION LOG - Standard

WELL NO.:	Installation:	Site:
Project No.:	Client/Project:	
HAZWRAP Contractor:		Drlg Contractor:
Comp. Start: (: __ m)		Comp. End: (: __ m)
Built By:		Well Coord.: ______



PROTECTIVE CSG
Material/Type ______
Diameter ______
Depth BGS ______ Weep Hole (Y/N)

GUARD POSTS (Y/N)
No. ______ Type ______

SURFACE PAD
Composition & Size ______

RISER PIPE
Type ______
Diameter ______
Total Length(TOC to TOS) ______

GROUT
Composition & Proportions ______
______
Tremied (Y/N)
Interval BGS ______

CENTRALIZERS (Y/N)
Depth(s) ______

SEAL
Type ______
Source ______
Setup/Hydration time ______ Vol. Fluid Added ______
Tremied (Y/N)

FILTER PACK
Type ______
Amt Used ______
Tremied (Y/N)
Source ______
Gr. Size Dist. ______

SCREEN
Type ______
Diameter ______
Slot Size & Type ______
Interval BGS ______

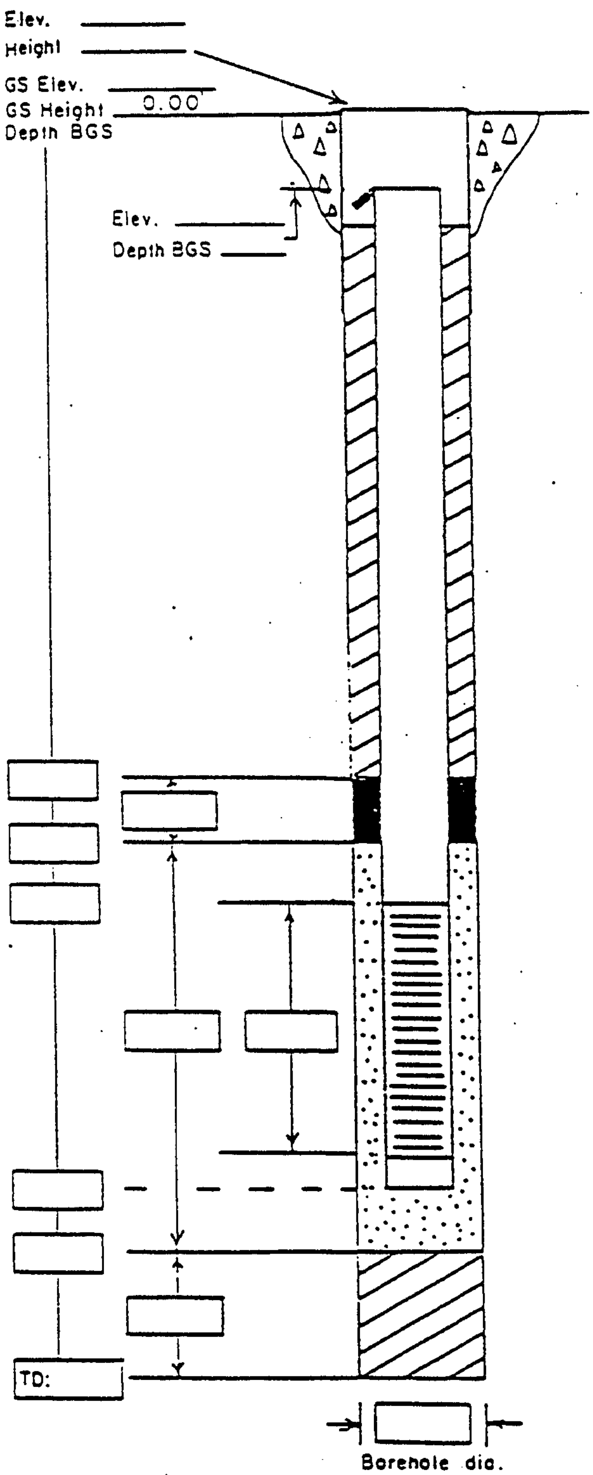
SUMP (Y/N)
Interval BGS ______ Length ______
Bottom Cap (Y/N)

BACKFILL PLUG
Material ______
Setup/Hydration time ______
Tremied (Y/N)

REV. DATE: JAN 1989

MONITORING WELL CONSTRUCTION LOG - Standard Flush Mount

WELL NO.:	Installation:	Site:
Project No.:	Client/Project:	
HAZWRAP Contractor:	Drlg Contractor:	
Comp. Start: (: __m)	Comp. End: (: __m)	
Built By:	Well Coord.: ____	



PROTECTIVE CSG
Material/Type ____
Diameter ____ Water Tight Seal (Y/N)
Depth BGS ____ Weep Hole (Y/N)

SURFACE PAD
Composition & Size ____

RISER PIPE
Type ____
Diameter ____
Total Length (TOC to TOS) ____

GROUT
Composition & Proportions ____

Tremied (Y/N)
Interval ____

CENTRALIZERS (Y/N)
Depth(s) ____

SEAL
Type ____
Source ____
Setup/Hydration time ____ Vol. Fluid Added ____
Tremied (Y/N)

FILTER PACK
Type ____
Amt Used ____
Tremied (Y/N)
Source ____
Gr. Size Dist. ____

SCREEN
Type ____
Diameter ____
Slot Size & Type ____
Interval BGS ____

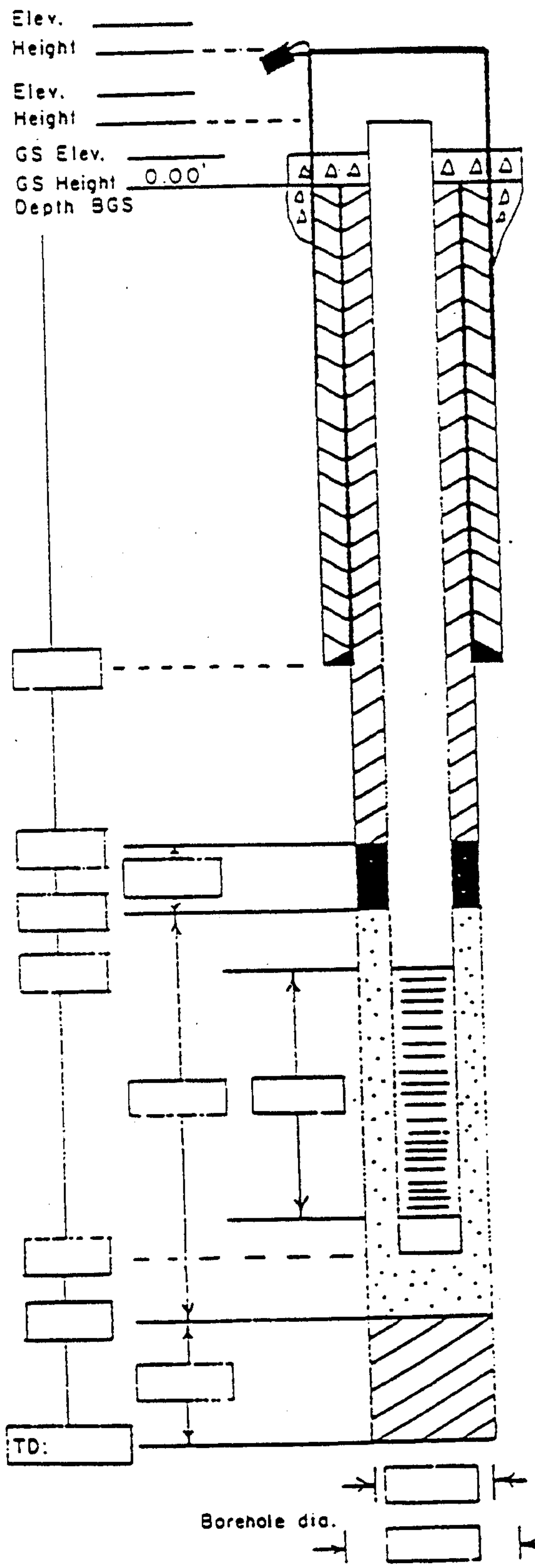
SUMP (Y/N)
Interval BGS ____ Length ____
Bottom Cap (Y/N)

BACKFILL PLUG
Material ____
Setup/Hydration time ____
Tremied (Y/N)

REV. DATE: JAN 1989

MONITORING WELL CONSTRUCTION LOG - Double Cased

WELL NO.:	Installation:	Site:
Project No:	Client/Project:	
HAZWRAP Contractor:		Drlg Contractor:
Comp. Start: (: __m)		Comp. End: (: __m)
Built By:		Well Coord: ______



PROTECTIVE CSG
Material/Type ______
Diameter ______
Depth BGS ______ Weep Hole (Y/N)

GUARD POSTS (Y/N)
No. ______ Type ______

SURFACE PAD
Composition & Size ______

SURFACE CSG
Type ______
Diameter ______ Total Length ______
GROUT: Setup/Hydration Time ______
Composition & Proportions ______
______
Interval BGS ______
Tremied (Y/N)

RISER PIPE
Type ______
Diameter ______
Total Length (TOC to TOS) ______
GROUT
Composition & Proportions ______
______
Interval BGS ______
Tremied (Y/N)

CENTRALIZERS (Y/N)
Depth(s) ______

SEAL
Type ______
Source ______
Setup/Hydration Time ______ Vol. Fluid Added ______
Tremied (Y/N)

FILTER PACK
Type ______
Amount Used ______
Source ______
Gr. Size Dist. ______
Tremied (Y/N)

SCREEN
Type ______
Diameter ______
Slot Size & Type ______

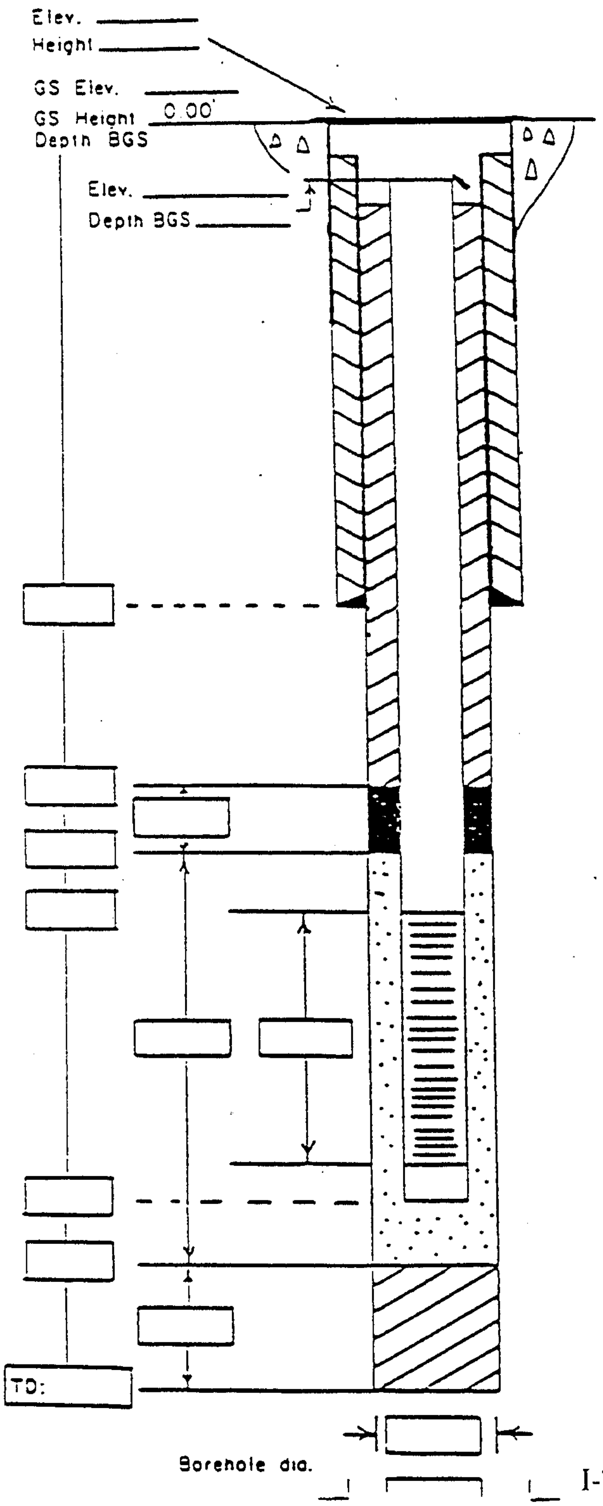
SUMP (Y/N)
Interval BGS ______ Length ______
Bottom Cap (Y/N)

BACKFILL PLUG
Material ______
Setup/Hydration Time ______
Tremied (Y/N)

REV DATE: JAN 1989

MONITORING WELL CONSTRUCTION LOG – Double Cased Flush Mount

WELL NO.:	Installation:	Site:
Project No:	Client/Project:	
HAZWRAP Contractor:	Drlg Contractor:	
Comp. Start: (: ___m)	Comp. End: (: ___m)	
Built By:	Well Coord: ______	



PROTECTIVE CSG
Material/Type ______
Diameter ______ Water Tight Seal (Y/N)
Depth BGS ______ Weep Hole (Y/N)

SURFACE PAD
Composition & Size ______

SURFACE CSG
Type ______
Diameter ______ Total Length ______
GROUT: Setup/Hydration Time ______
Composition & Proportions ______

Interval BGS ______
Tremied (Y/N)

RISER PIPE
Type ______
Diameter ______
Total Length (T.O.C to TOS) ______
GROUT
Composition & Proportions ______

Interval BGS ______
Tremied (Y/N)

CENTRALIZERS (Y/N)
Depth(s) ______

SEAL
Type ______
Source ______
Setup/Hydration Time ______ Vol. Fluid Added ______
Tremied (Y/N)

FILTER PACK
Type ______
Amount Used ______
Source ______
Gr. Size Dist. ______
Tremied (Y/N)

SCREEN
Type ______
Diameter ______
Slot Size & Type ______

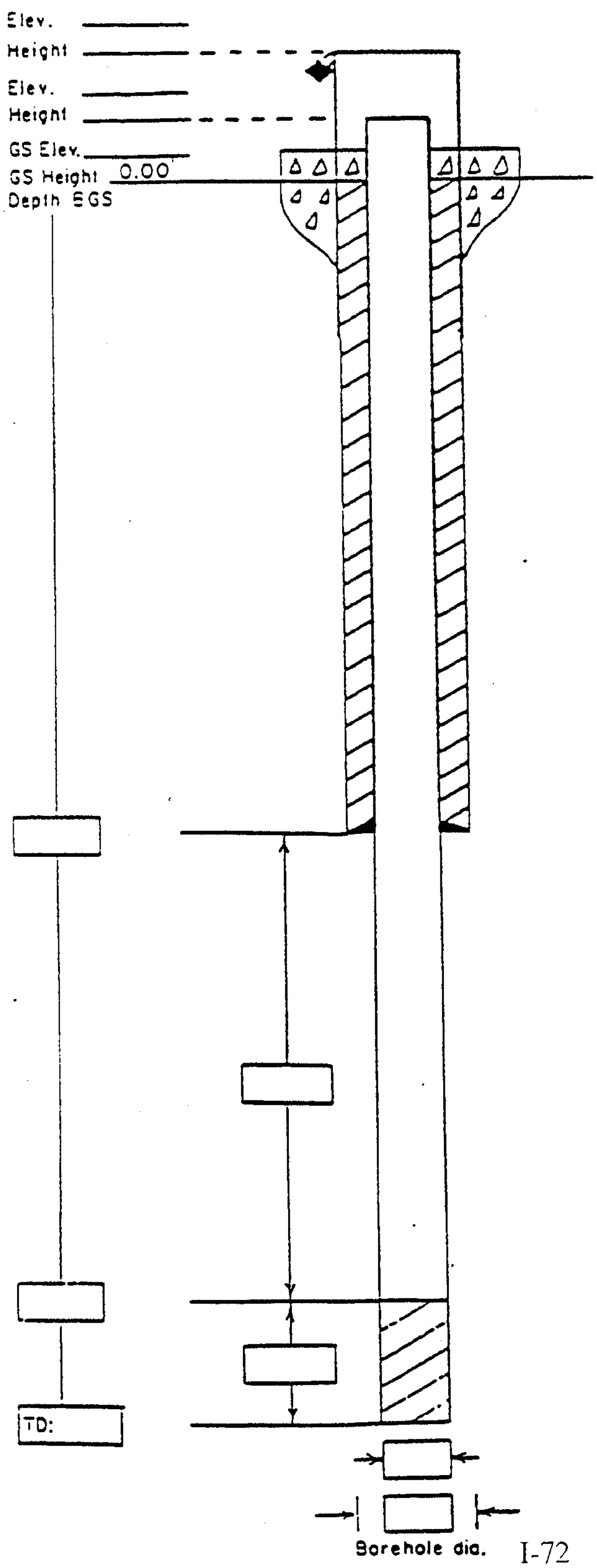
SUMP (Y/N)
Interval BGS ______ Length ______
Bottom Cap (Y/N)

BACKFILL PLUG
Material ______
Setup/Hydration Time ______
Tremied (Y/N)

REV. DATE: JAN 1989

MONITORING WELL CONSTRUCTION LOG – Open Hole

WELL NO.:	Installation:	Site:
Project No.:	Client/Project:	
HAZWRAP Contractor:	Drlg Contractor:	
Comp. Start: (: __m)	Comp. End: (: __m)	
Built By:	Well Coord.: ____	



PROTECTIVE CSG
Material/Type ____
Diameter ____
Depth BGS ____ Weep Hole (Y/N)

GUARD POSTS (Y/N)
No. ____ Type ____

SURFACE PAD
Composition & Size ____

RISER PIPE
Type ____
Diameter ____
Total Length(TOC to TOS) ____

GROUT
Composition & Proportions ____

Tremied (Y/N)
Interval BGS ____

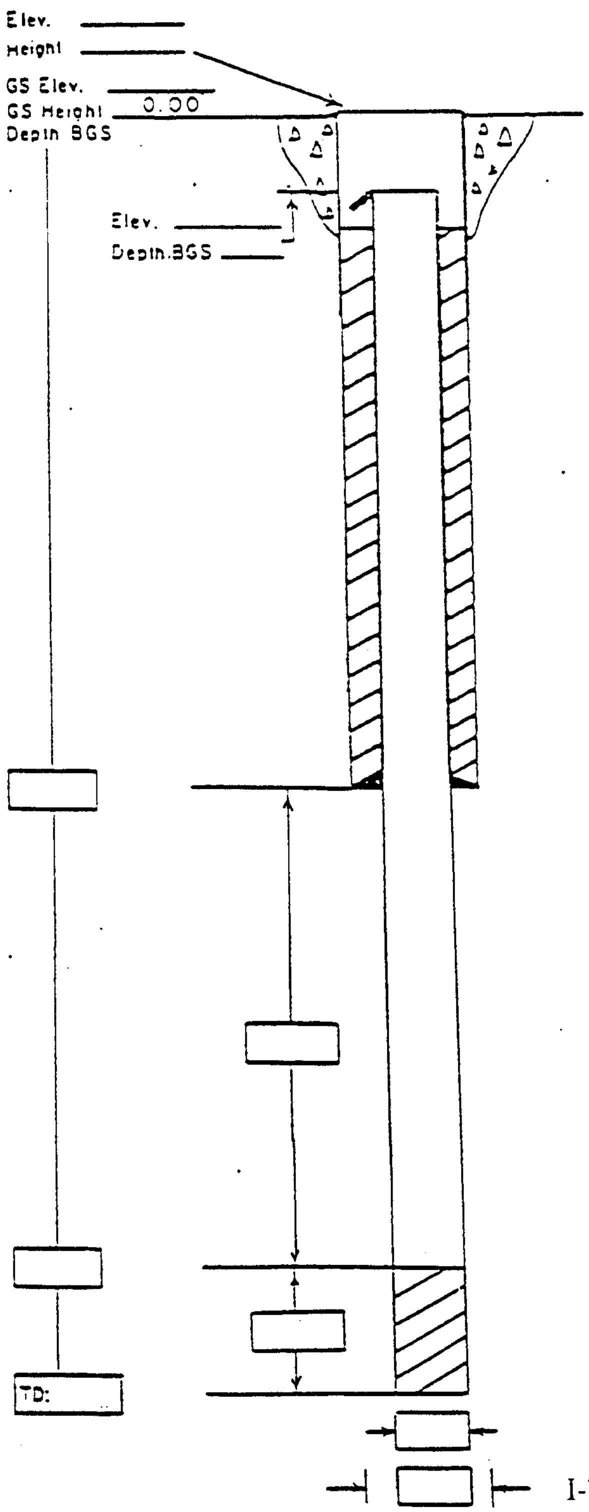
CENTRALIZERS (Y/N)
Depth(s) ____

BACKFILL PLUG
Material ____
Setup/Hydration time ____
Tremied (Y/N)

REV DATE: JAN 1989

MONITORING WELL CONSTRUCTION LOG – Open Hole Flush Mount

WELL NO.:	Installation:	Site:
Project No.:	Client/Project:	
HAZWRAP Contractor:	Drig Contractor:	
Comp. Start: (: __ m)	Comp. End: (: __ m)	
Built By:	Well Coord.: ______	



PROTECTIVE CSG
Material/Type ______
Diameter ______ Water Tight Seal (Y/N)
Depth BGS ______ Weep Hole (Y/N)

SURFACE PAD
Composition & Size ______

RISER PIPE
Type ______
Diameter ______
Total Length(TOC to TOS) ______

GROUT
Composition & Proportions ______

Tremied (Y/N)
Interval ______

CENTRALIZERS (Y/N)
Depth(s) ______

BACKFILL PLUG
Material ______
Setup/Hydration time ______
Tremied (Y/N)

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FIELD PROCEDURE FP 5-3

PIEZOMETER INSTALLATION

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Subject	Procedure No. FP 5-3	Rev. 0	Page 1 of 6
PIEZOMETER INSTALLATION	Issue Date 05/25/90		Effective Date 07/02/90
	Supersedes Procedure Number 630 FP 29	Rev. 0	Date
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to provide general reference information and technical guidance pertaining to the construction and completion of a piezometer (well-point) used for measuring water level elevations.

2.0 SCOPE

This procedure applies to the installation and development of a piezometer and well-point installation. The methods described may be modified by project-specific requirements for piezometer and well point construction. In addition, many states have specific requirements and regulations pertaining to well construction, permitting, and completion. Consequently, these requirements must be ascertained during the development of the Project Work Plan.

3.0 REQUIREMENTS

Piezometers are an efficient and relatively inexpensive method of determining static water levels, in addition to establishing horizontal and vertical ground water flow directions.

4.0 REFERENCES

4.1 Driscoll, G. Fletcher, 1986. *Groundwater and Wells*. Johnson Division, St. Paul, Minnesota, pp. 740-763.

4.2 U.S. Environmental Protection Agency, 1987. *Ground Water*, Publication EPA/625/6-87/016.

4.3 U.S. Dept. of the Interior, 1981. *Ground Water Manual*, A Water Resources Technical Publication, Water and Power Resources Services.

4.4 HAZWRAP, February 1989, *Quality Control Requirements for Field Methods*, DOE/HWP-69.

4.5 Engineering-Science, Inc., 1990. *Remedial Investigation Report*, Duluth, Minnesota Air National Guard Base.

5.0 DEFINITIONS

Monitoring Well - A well which is properly screened (if screening is necessary), cased, and seated and is capable of providing a ground-water level and sample representative of the zone being monitored.

Piezometer - A pipe or tube inserted into an aquifer, open to water flow at the bottom and open to the atmosphere at the top and used to measure water level elevation. Piezometers may range in size from 1/2-inch diameter plastic tubes to well points or monitoring wells.

Well Point - A screened or perforated tube (1 1/4" - 2" in diameter) with a solid, conical, hardened point at one end. The well point may be installed into the ground with a sledge hammer, drive weight, mechanical vibrator or by drilling (i.e., HSA, Rotosonic). The exact method of well point installation is dependent on the type lithology and sampling depth. Well points may be used for ground-water injection and recovery, as piezometers (i.e., to measure water levels), or to provide ground-water samples for water quality screening.

6.0 RESPONSIBILITIES

6.1 Driller

The driller provides to the Field Geologist adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force to perform all phases of proper monitoring well construction. He is responsible for obtaining, in advance, any required permits for monitoring well construction.

6.2 Rig Geologist

The Rig Geologist supervises well construction by the Driller, documents all phases of well construction and installation, and insures that well construction is adequate to provide a representative ground-water sample. Geotechnical engineers, field technicians, or other suitably trained personnel may also serve in this capacity.

7.0 EQUIPMENT

7.1 Field Log Book and Indelible Ink Pen
7.2 Monitoring Well Construction Log
7.3 Folding or Retractable Engineers Rule
7.4 Weighted Tape
7.5 Slot Size or Feeler Gauge
7.6 Material required for construction and completion of piezometer

8.0 PROCEDURE

The following guidelines apply to the construction, documentation, and completion of monitoring wells. However, in many cases, these requirements are also pertinent to piezometer and well point installation.

8.1 Piezometer Installation

Techniques involved in piezometer or well point installation vary from site to site and are largely dependent on the overall lithology of the area in question. For example, in areas of mixed lithologies or areas containing copious amounts of clay, simple piezometric or well point installation may not be practical or effective. Difficulties encountered in driving a piezometer or well point in boulder ridden glacial tills is obvious (i.e., bent, or broke pipe length, screen damage).

Piezometer or Well Point Borehole Installation

- Inspect the screen to insure that no damage has occurred during shipment and decontamination. Also record the type and class of material and screen slot size. Check the slot size with a feeler gauge to insure that the screens are properly labeled.

- Prior to placing well materials in the borehole place a 1 to 2 foot backfill of filter pack material below the base of the screen. The filter pack will consist of chemically inert (e.g. clean quartz sand, silica or glass beads) well rounded and dimensionally stable.

- Assemble the well casing and screen and place the material in the borehole. Attach centralizers as specified in the Project Work Plan to ensure that each well is straight as possible and centered in the borehole. A sump or sampling cup device 1 to 2 foot long may be attached to the bed of the well to aid in collecting fine-grained sediments and to capture dense immiscible contaminants for analysis.

  NOTE: All well screen, riser pipe, sump, bottom plug and cap will be threaded and flush jointed. No glues or solvents are to be used in monitoring well installation.

- Record the depth of the base of the well and the top of the screen on the monitoring well construction log.

Placement of Filter Pack and Annular Seal

- Place the monitoring wells filter pack by slowly pouring filter pack material directly or pumping a sand slurry through a tremie pipe into the annulus between well screen and the open borehole wall. If the borehole will not stand open place filter pack material directly into the annulus between the auger wall and the well casing and screen. Then gradually pull back the auger string in small increments (2 feet at a time) to allow the sand to settle around the screen below the augers. Care will be taken to prevent filter pack material from bridging between the borehole wall or augers and the well screen and riser pipe.

NOTE: The filter pack material will be chemically inert (e.g., clean quartz sand, silica, or glass beads) with particles that are well-rounded. Fabric filters are not permitted.

- The filter pack material will be placed from the bottom of the well to a nominal 2 feet above the top of the screen. The depth to the top of the sand pack will be recorded on the Monitoring Well Construction Log form. Note the number of bags of sand used.

- Tremie, or for shallow wells (≤ 35 feet) gravity feed, bentonite pellets or chips (not powder) onto the top of the filter pack to form a 2 to 3 foot seal. Bentonite pellets must be used if the seal is to be sealed below the water table. Grannular, flake or slurried bentonite may be used above the water table. If a tremie pipe is used, slowly withdraw the pipe as the bentonite is added to ensure even placement around the annulus. Check the depth with a weighted tape.

- Follow manufactures specifications for hydration time. Record the depth to the top of the bentonite seal, the number of buckets/bags of bentonite used, and the amount of water added for hydration (if applicable).

  NOTE: The annular seal material must be chemically compatible with the well materials and contaminants and chemically insert so it does not affect the quality of ground-water samples. The permeability of annular seals will be one to two orders of magnitude less than the surrounding formation.

- Tremie a neat cement-bentonite grout above the bentonite seal by pumping it through a tremie pipe (with its bottom opening set about 1 foot above the top of the well seal to prevent disturbance of the seal during pumping activities), and allow the grout to rise in the borehole annulus to the bottom of the frost line. Some piezometers may be backfilled to the surface with drill cuttings.

  NOTE: Cement-bentonite grout typically consists of one 94-pound sack of Portland cement and 3 to 5 pounds of powdered bentonite with 6.5 gallons of water. Mix the bentonite and water first, and then add the cement (Driscol 1986).

- Place concrete from the frost line to the base of the well completion.

Above Ground Well Completion

- Notch the north side of the well casing with a hacksaw or file. The notch will be the point from which surveys and subsequent water level measurements will be measured. Ensure no filings or PVC shavings enter the well.

- For wells that are completed above the ground surface the finish casing should extend approximately 2-1/2 feet above the land surface with a protective steel riser pipe equipped with a hinged, loose-fitting cap that can be locked to prevent unauthorized entry. Sufficient space must be allowed between the protective casing lid and the top of the well riser

pipe for a well cap. The minimum size for a 2-inch well is a 6-inch protective casing. The riser pipe should extend approximately 2 feet above the land surface.

- Construct a concrete pad around the protective casing within 24 hours of well installation. Embed a brass surveyors pin in the concrete pad and stamp the well identification number and elevation of the top of the casing in the pin and on the top of the Protective Casing and the Inner Casing. The pad size shall be as stated in the project-specific work plan.

- Drill a 1/4 inch diameter weep hole into the side of the protective casing near the top of the concrete pad to permit drainage.

- Install three 3-inch diameter by 8-foot long, concrete-filled, steel guard posts radially around the concrete pad. The guard posts will extend approximately four feet into the ground with independent concrete footings.

Simple Piezometer or Drive Point Design and Installation

Each piezometer should consist of three essential components:

- A watertight standpipe of the smallest possible diameter, consistent with the method of reading, attached to the top and extending to the surface.

- A tip consisting of a well screen, porous tube, or other similar feature, and in fine-grained materials, a surrounding zone of filter sand.

- A seal consisting of cement grout, bentonite slurry, or other similar slowly permeable material placed between the standpipe and the hole to isolate the zone.

If the area under investigation is underlain by porous sands, a simple piezometer or well point may be installed using a detachable drive point attached to a stainless steel pipe. The pipe is driven into the ground using a sledge hammer, drive weight or mechanical vibrator.

- Using a hand auger or hand-held power auger, drill a vertical pilot hole to the desired depth. The pilot hole should be of the same or slightly larger diameter than the piezometer casing.

- Make up-segment of riser pipe of appropriate length for driving using a slotted piezometer point or slotted screen with attached drive point at the bottom.

- Drive the first segment to within about 1 foot of the ground surface.

- Continue adding riser pipe segments and driving until the screened portion is seated at the correct depth.

- Construct a seal of cement grout, bentonite slurry, or other equally low permeable material.

- The top of the pipe should extend at least one foot above the ground surface unless a pit installation is necessary.

- Fit the top with a screwcap or locking cap containing a small hole to permit adjustment of air pressure in the pipe. Where artesian flow conditions are present, a tight-fitting cap which has been drilled and tapped for a Bourdon gauge or mercury manometer should be used.

8.2 Limitations

- Piezometers are not generally intended to be used for the collection of ground-water samples for full laboratory analysis, unless completion procedure would support that data quality level. Samples may be collected and used for screening.

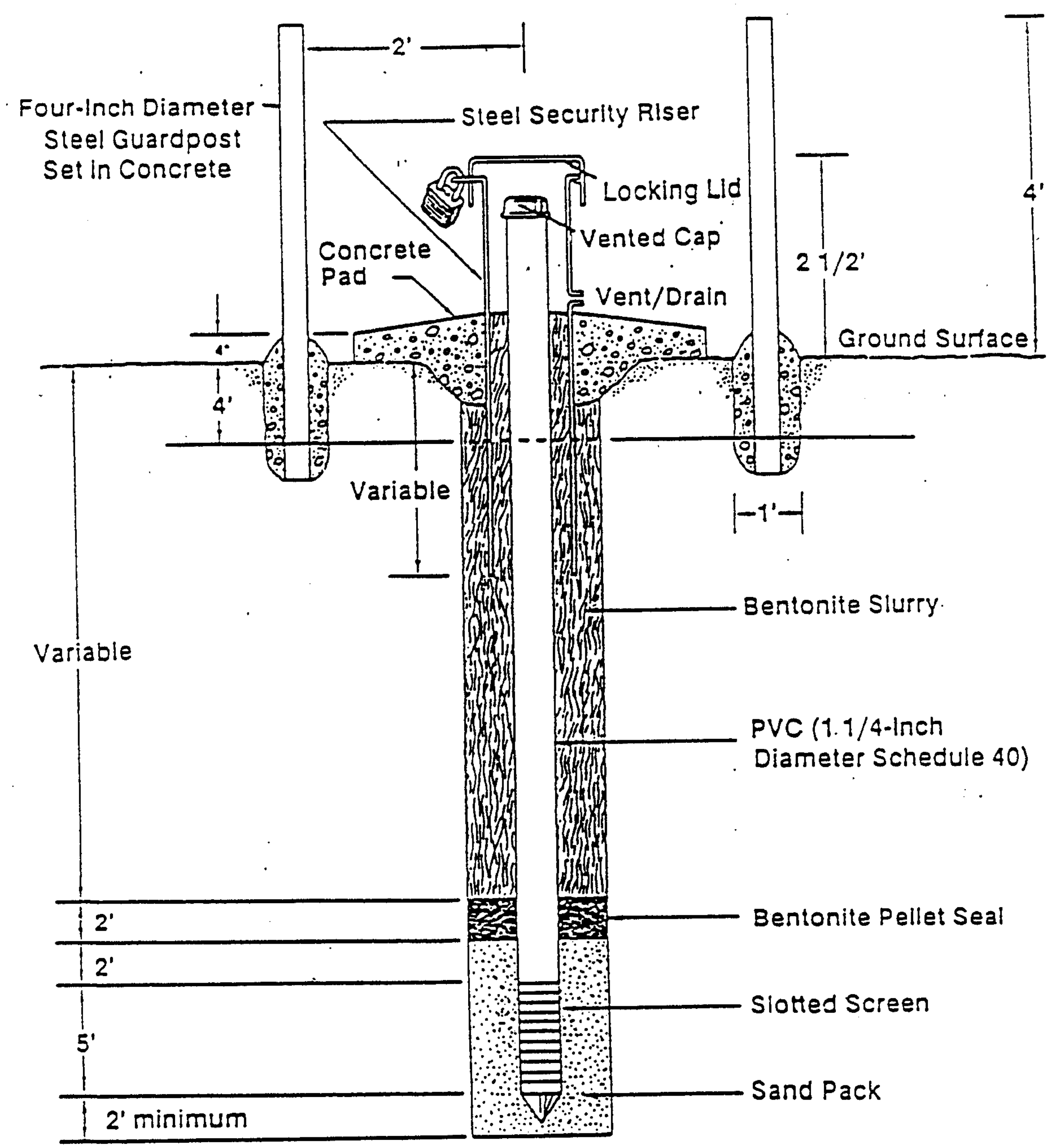
- Drive point piezometers should be considered to be short term (~2 weeks) temporary installations and should be abandoned as soon as the data needs are met.

9.0 ATTACHMENTS

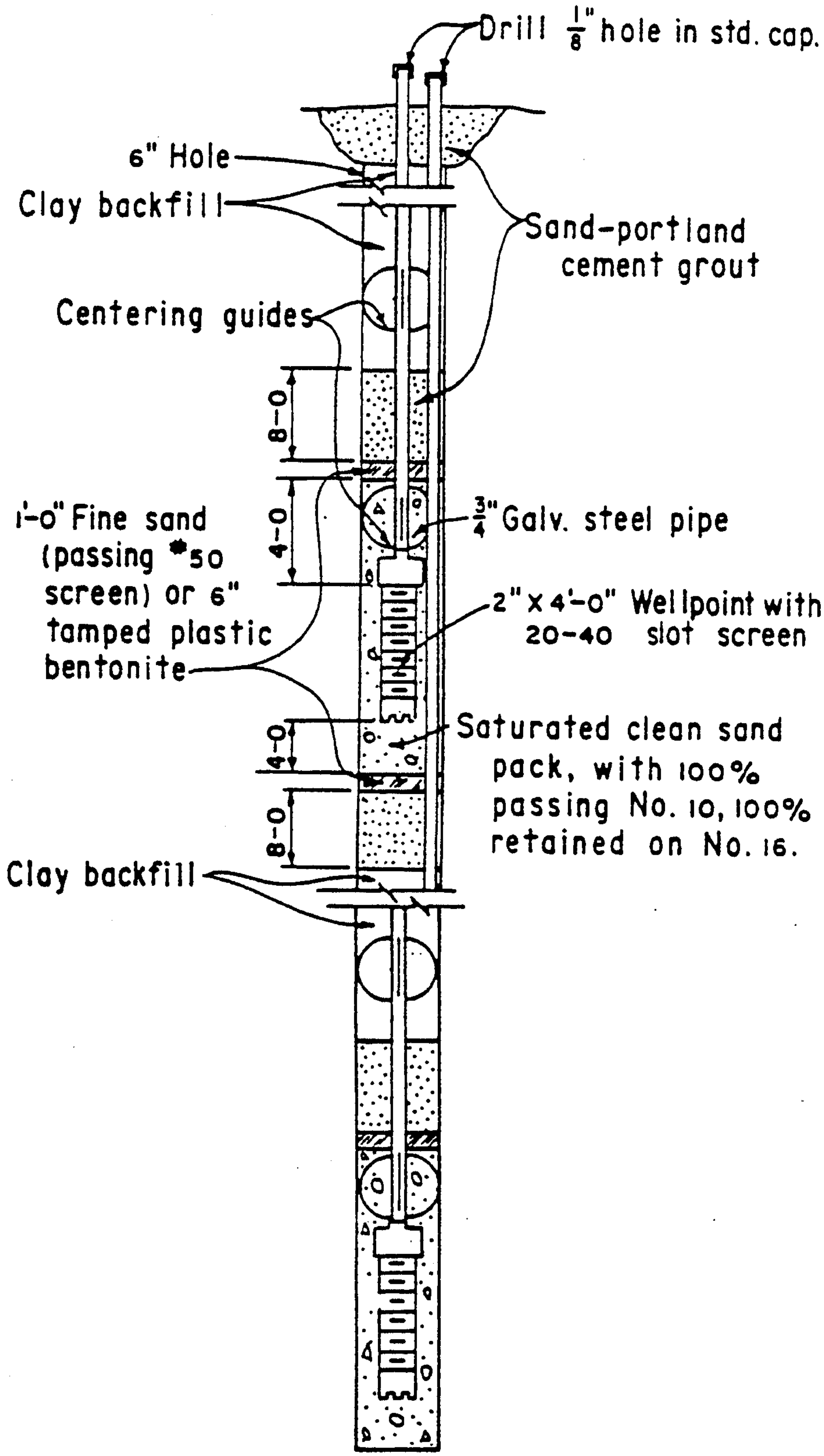
9.1 Typical well point construction used in areas containing clay rich glacial sediments.

9.2 Typical Piezometer Diagram.

TYPICAL WELL POINT CONSTRUCTION
(Used in Areas Containing Clay Rich Glacial Sediments)



TYPICAL PIEZOMETER DIAGRAM



FIELD PROCEDURE FP 5-4

WELL DEVELOPMENT

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1.0 PURPOSE

The purpose of this procedure is to define the requirements for developing monitoring wells to increase permeability and ensure a representative sample of ground water obtained from the aquifer.

2.0 SCOPE

This procedure applies to development of wells by either the bailing or pumping technique.

3.0 REQUIREMENTS

The purpose of well development is to stabilize and increase the permeability of the gravel pack around the well screen, and to restore the permeability of the formation which may have been reduced by drilling operations. The selection of the well development method shall be made by a hydrogeologist and is based on the drilling methods, well construction and installation details, and the characteristics of the formation in which the well is screened. Any equipment introduced into the well during development shall be decontaminated in accordance with FP 3-1.

Each monitoring well will be developed by bailing or pumping. Centrifugal pumps will generally be used to develop shallow wells with high yield. Submersible pumps will generally be used to develop deep wells of low to high yield. Equipment availability or other circumstances may occasion the use of a submersible pump to develop a shallow high-yield well or hand pumps and bailers to develop any well. Physical and chemical parameters including temperature, pH, specific conductance and turbidity of the water will be measured during well development.

The development water will be stored in appropriate containers, analyzed and handled in accordance with project-specific Work Plan.

Bailers used for development must be decontaminated in accordance with appropriate decontamination procedures.

4.0 REFERENCES

4.1 Driscoll, F.G., 1986, *Groundwater and Wells*: Johnson Division, St. Paul, Minnesota, 1108 p.

4.2 HAZWRAP, February 1989, *Quality Control Requirements for Field Methods*, DOE/HWP-69.

5.0 DEFINITIONS

Swabbing - Swabbing is a process in which a plunger-type device called a surge plunger or surge block, is moved up and down within the well screen to force ground water to alternately flow in and out through the sand pack. This back and forth movement of water facilitates removal of fines from the formation immediately adjacent to the well, while preventing bridging (wedging) of sand grains.

6.0 RESPONSIBILITIES

6.1 Field Operations Leader

The Field Operations Leader is responsible for proper implementation of this procedure.

6.2 Field Geologist

The Field Geologist is responsible for withdrawing sufficient water to clarify the well, and for performing physical measurements such as pH, temperature, specific conductance, and turbidity to ensure proper development. All data should be entered into the field logbook and on the Well Development Log (Attachment 9.1).

7.0 EQUIPMENT

7.1 Pumps.

7.2 Pump suction lines.

7.3 Swabbing equipment (as necessary).

7.4 Bailers.

7.5 Steel retractable engineer's measuring tape calibrated to 0.01 foot.

7.6 Water level indicators.

7.7 pH meter.

7.8 Specific conductance meter.

7.9 Nephelometer.

7.10 Mercury thermometer.

7.11 Drums to contain the development water.

7.12 Field logbook.

7.13 Well development log.

8.0 PROCEDURE

8.1 Development

- Open and check the condition of the well head. Check for organic vapors.
- Measure the water level in the well before development begins. Record the value to the nearest 0.01 foot in the field logbook.
- Prepare the equipment for developing the well. For screened intervals longer than 10 feet, develop the well in 2 to 3 foot intervals from bottom to top.
- Continue development until water appears to run clear. Collect a sample per Section 8.2.
- Sampling will be repeated until consistent measurements of pH, temperature and specific conductance are achieved in three consecutive samples.
- Development will be considered complete when the three consecutive measurements, each separated by five minutes, have pH values within ± 0.1 units, temperature within ± 1.0 degree Celsius and specific conductance within ± 10 micromhos per centimeter. The turbidity must be less than 5 NTU.
- If the NTU objective is not reached within 8 hours, a sample will be collected for analysis of the silt content by X-ray diffraction. If silt and clay are not present the well will be considered developed.
- If silt and clay are present, the sample will be analyzed for Total Organic Carbon (TOC). If TOC is present, the well will be considered developed.
- If TOC is not present, consideration will be given for further development or abandonment.

8.2 Ground-Water Sampling

A pump or bailer will then be lowered into the well. Water will be removed from the well at varying depths along the entire interval of the screen until the effluent begins to clear of suspended solids. A sample of the development water will be tested for clarity, pH, temperature and specific conductance.

1. Temperature Measurement: The temperature of the water will be measured to within one degree Celsius (°C) using a mercury thermometer. This measurement will also be used to calibrate the pH and conductivity meters.

2. pH Measurement: The pH of the water will be measured within 0.1 pH unit using a portable pH meter. The meter will be calibrated daily, per FP 7-4.

3. Specific Conductivity Measurement: The specific conductivity of the water will be measured with a portable specific conductivity meter. The instrument will be calibrated per FP 7-5.

4. Turbidity: Turbidity will be measured using a nephelometer with a range of 0 to 10 nephelometric turbidity units, an accuracy of ± 0.2 NTU and a resolution of 0.1 NTU. This instrument will be calibrated daily with a 5.0 NTU standard solution cell.

8.3 Development Methods, Restrictions, and Limitations

Overpumping and Backwashing

- This method develops the well by drawing the water level down at a given rate and then reversing the flow direction so water is passing from the well into the formation.
- The acceptable method of backwashing is accomplished by starting and stopping the pump intermittently.

Surging with a Surge Plunger

- A surge plunger (also called a surge block or swab) is approximately the same diameter as the well casing and is used to agitate the water.
- In formations with a high yield, a solid plunger is the most effective.
- In formations with a high yield, a valved surge plunger may be preferred, as they are designed to create greater inflow than outflow during surging.

High-Velocity Jetting

- Water used in high-velocity jetting shall be of known quality (i.e., a sampled source).
- The amount of water added shall be recorded in the field logbook.
- Jetting should be used only if other methods ar ineffective.
- The jetting tool should be rotated and slowly raised and lowered along the length of the screen to insure complete development.

Compressed Air

- For the closed-well method (i.e., increase air pressure in a sealed well forcing water out, then releasing pressure and allowing water to flow back in), care shall be taken not to lower the water level below the top of the screen.
- A no time in the open-well method shall air be injected directly into the screened interval.

9.0 ATTACHMENTS

9.1 Well Development Log.

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WELL DEVELOPMENT LOG

WELL NO.: Page ______ of ______

Installation: Site:

Project No.: Client/Project:

HAZWRAP Contractor: Dev. Contractor:

Dev. Start: (: __ m) Dev. End: (: __ m) Csg Dia.:

Developed by: Dev. Rig (Y / N)

Dev. Method ________________________________

Equipment ________________________________

Pre-Dev. SWL ______ Maximum drawdown during pumping ______ ft at ______ gpm

Range and Average discharge rate ______ gpm

Total quantity of material bailed ______

Total quantity of water discharged by pumping ______

Disposition of discharge water ______

Time	Volume Removed (gal)	Water Level ft.BTOC	Turbidity	Clarity/ Color	Temp. °C	pH	Conductivity	Remarks

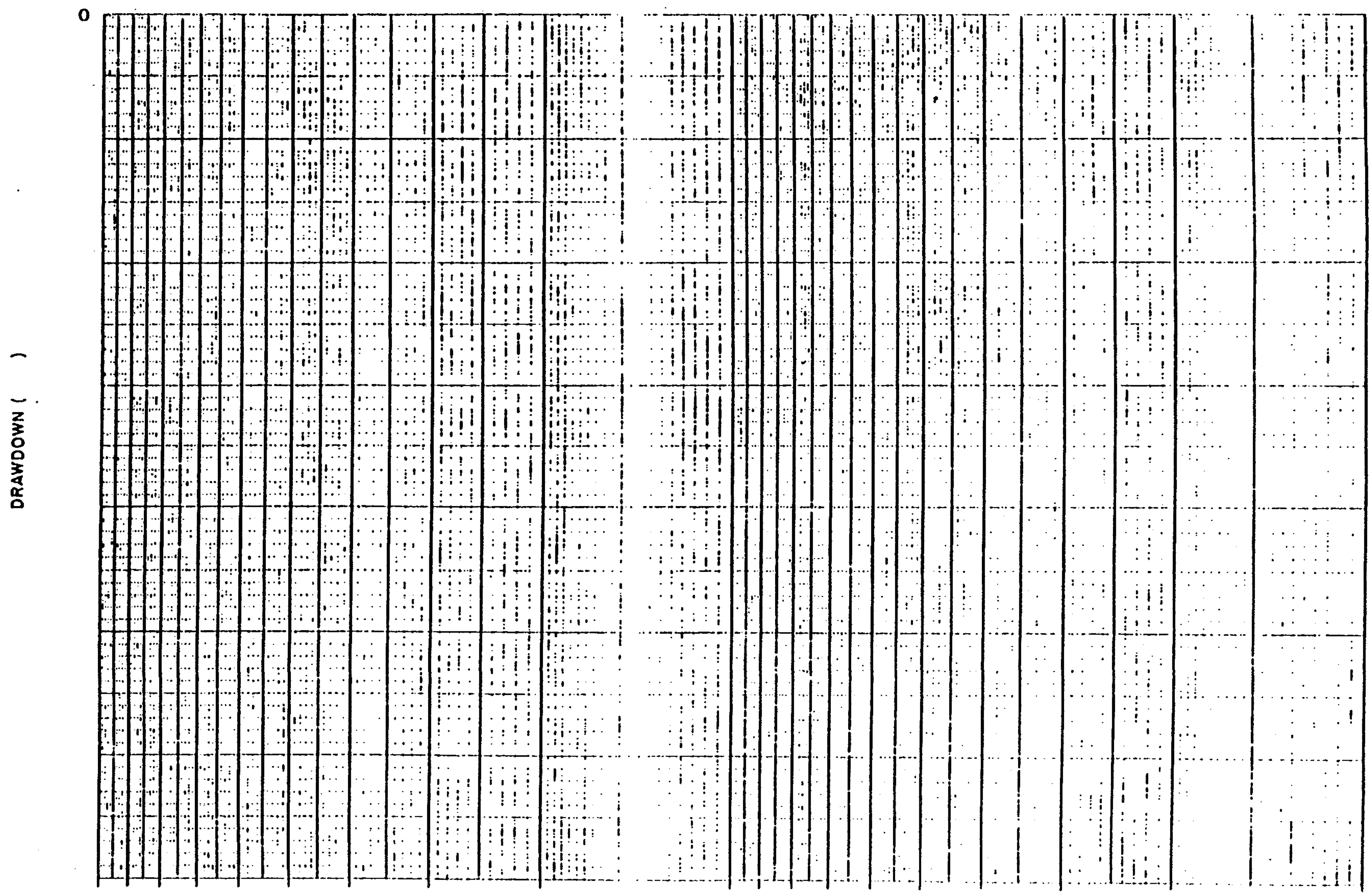
POST DEVELOPMENT WATER LEVEL RECOVERY GRAPH

REV. DATE: JAN 1989

Well Recording Instrument ______________________

Start Recovery: ________ (: __m) End Recovery: ________ (: __m) Total Recovery Time __________

Beginning WL ______________ Final SWL ________________



FIELD PROCEDURE FP 5-5

WELL PURGING - BAILING METHOD

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Subject	Procedure No.	Rev.	
	FP 5-5	0	Page 1 of 5
WELL PURGING - BAILING METHOD	Issue Date 05/25/90		Effective Date 07/02/90
	Supersedes Procedure Number 630 FP 13	Rev.	Date
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to provide general reference information on well purging by the bailing method prior to the sampling of ground water wells. The methods and equipment described are for the purging of water samples from the saturated zone of the subsurface.

2.0 SCOPE

This procedure applies to purging water from relatively low volume wells, or from very deep wells. Reference Procedure FP 5-6 Well Purging - Pumping Method for wells too voluminous for purging by the bailing method.

3.0 REQUIREMENTS

Methods for purging from completed wells include the use of pumps, compressed air, bailers, and various types of samplers. The primary considerations in obtaining a representative sample of the ground water are to avoid collection of stagnant (standing) water in the well and to avoid physical or chemical alteration of the water due to sampling techniques. In a non-pumping well, there will be little or no vertical mixing of water in the well pipe or casing, and stratification will occur. The well water in the screened section will mix with the ground water due to normal flow patterns, but the well water above the screened section will remain isolated and become stagnant.

4.0 REFERENCES

4.1 United States Environmental Protection Agency, 1987. *Ground Water Handbook*: EPA/625/6-87/016.

5.0 DEFINITIONS

Bailer - A cylindrical section of PVC, stainless steel, or Teflon closed at the top, and with a floating ball check-valve at the bottom. The bailer is submerged, the ball floats, and water enters from the bottom. As the bailer is raised, the ball settles on the bottom creating a seal, allowing retrieval of a quantity of trapped water.

6.0 RESPONSIBILITIES

6.1 Project Manager

The Project Manager is responsible for reviewing the purging procedures used by the field crew and for performing in-field spot checks for proper purging procedures.

6.2 Site Hydrogeologist or Geochemist

Responsible for selecting and detailing the specific well purging techniques and equipment to be used, documenting these in the project-specific work plan, and properly briefing the site sampling personnel.

6.3 Site Geologist

The Site Geologist is primarily responsible for the proper well purging techniques. When appropriate, such responsibilities may be performed by other qualified personnel (engineers, field technicians). The Geologist will be responsible for purging of wells, performing necessary physical measurements and observations, and containment of purged water. He must record pertinent information including amount of water purged, pH, specific conductivity of emperature, and turbidity in the Field Log Book and on the Ground Water Sampling Form, Attachment 9.1.

7.0 EQUIPMENT

7.1 Bailers.

7.2 One-quarter inch nylon rope.

7.3 Steel retractable engineer's measuring tape (Calibrated to 0.01 foot).

7.4 Water level indicators.

7.5 Swabbing equipment (as necessary).

7.6 pH meter.

7.7 Specific conductance meter.

7.8 Nephelometer.

7.9 Mercury thermometer.

7.10 HNu photoionization detector.

7.11 Drums to contain the development water.

7.12 Ground water sampling form, Attachment 9.1.

7.13 Field log book.

8.0 PROCEDURE

8.1 General

- The amount of flushing a well should receive prior to sample collection will depend on the intent of the monitoring program and the hydrogeologic

conditions.

- For the volumetric method, generally three to five well volumes are considered effective for purging a well.
- An alternative method of purging a well is to purge continuously (using a low volume low flow pump) while monitoring specific conductance, pH, and water temperature until the values stabilize.
- The site hydrogeologist, geochemist, and risk assessment personnel shall define the objective of the groundwater sampling program in the Work Plan.

8.2 Calculations of Well Volume

To insure that the proper volume of water has been removed from the well prior to sampling it is first necessary to determine the volume of standing water in the well pipe and the volume of water in the filter pack below the well seal. The volume can be easily calculated by the following method. Calculations shall be entered in the field logbook:

1. Obtain all available information on well construction (location, casing, screens, etc.).
2. Determine well or casing and borehole diameter.
3. Measure and record static water level (Depth below ground level or top of casing reference point), using one of the methods described in FP 7-2.
4. Determine depth of well (if known from past records) by sounding using a clean, decontaminated weighted tape measure.
5. Calculate number of linear feet of static water (total depth or length of well pipe minus the depth to static water level).
6. Calculate the volume of water in the casing and the volume of water in the filter pack.

$$Vc = \pi\ (di/2)^2\ (TD-H)$$

$$Vf = \pi\ \frac{dH^2}{2} - \frac{do^2}{2}$$

TD - (S or H) (P)

If S > H use S, if S < H use H

$$Vt = (Vc + Vf)\ (7.48)$$

Where:

Vc = Volume of water in casing, ft^3
Vf = Volume of water in filter pack, ft^3

Vt	=	Total volume, gal
di	=	inside diameter of casing, ft
do	=	outside of diameter of casing, ft
dH	=	diameter of borehole, ft
TD	=	total depth of well, ft
H	=	depth to water, ft, from ground surface
S	=	depth to base of seal, ft, from ground surface
P	=	estimated porosity of filter pack (for most Ottawa, Morie #1 sand or glass beads this value is estimated at a range of 30 to 35%)

7. Determine the minimum number of volumes to be evacuated before sampling.

8.3 Well Purging by Bailing

- Remove protective foil from the top of the bailer.
- To prevent bailer from getting stuck in the well, the loose end of the rope will be cut short enough not to extend beyond the sloping portion of the bailer barrel.
- The bailer will be slowly lowered into the well to the desired level. NOTE: If resistance is encountered when lowering into the well, THE BAILER WILL BE WITHDRAWN FROM THE WELL, and the Field Operations Leader informed.
- The rope will be secured to the protective casing of the well or to the Geologists wrist.
- To prevent the introduction of foreign contaminants into the well, the bailing rope will not be allowed to contact the ground.
- The bailer will be withdrawn from the well and the purge water poured into the receptor drum.
- The bailer will be lowered and balesful of water withdrawn repeatedly until the required minimum of three well volumes have been purged.
- Record total volume of water removed on the Ground Water Sampling Form (Attachment 9.1) and in the field log book.
- Monitor purge water for physical parameters including pH, conductivity, temperature, and turbidity and record these values on the Ground Water Sampling Form (Attachment 9.1) and the Field Log Book.
- Purging will continue until the required volume of water has been removed and the physical parameters have stabilized so that pH is ± 0.1 su, conductivity ± 10 umhos and temperature is ± 1 °C, within three successive intervals.
- Whenever the receptor drum has become filled, the water shall be stored,

analyzed and disposed of in accordance with the project-specific Work Plan.

- Decontaminate the bailers per FP 3-1.

8.4 **Restrictions and Limitations**

- Bailers are the simplest evacuation devices and offer several advantages:
  - few limitations on size and materials;
  - no external power source needed;
  - bailers are inexpensive and can be dedicated to the well to reduce cross-contamination;
  - minimal outgassing of volatiles;
  - easy to contaminate.
- Limitations on the use of bailers include:
  - time consuming to remove stagnant water column;
  - transfer of sample may cause aeration; and
  - use of bailers is physically demanding, especially in warm temperatures at protection levels above Level D.

9.0 **ATTACHMENTS**

9.1 Ground-Water Sampling Form

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ATTACHMENT 9.1
FP 5-5
2 PAGES

GROUND-WATER SAMPLING FORM

Revision Date: January 1989

3. GROUNDWATER SAMPLING FORM

1. Date/Time ____________ Sample No. ____________
2. Location ____________
3. Well No. ____________ Sketch on Back [Y or N] ______
4. Total Depth ____________ Number of Screened Interval(s) ______
5. Depth to Screen/Length(s) ____________
6. [Y or N] Well Secure? Comments ____________
7. Sampler ____________ Other present ____________
8. Organic Vapor Detector FEL No. ________, Reading ________
9. Weather: Wind ______, Precipitation ______, Air Temperature ______
10. Water Level Measurement: FEL No. ____________
    [Y or N] Well Labeled ______, Elev. Ref. For Water Level ______
    Comments ____________
    Odor ____________
11. Depth to Product / Depth to Interface/Water / Thickness

	Depth to Product	Depth to Interface/Water	Thickness
1st	______	______	______

12. Casing Type ________, I.D. ________, Gal/Ft. ________
    (Show derivation for gal/ft of casing)
13. Total Depth ________ - Depth to Water ________ = Ht. ________
14. Well Volume ________ = Ht. ________ * Gal/Ft. ________
15. Required Purge Volume ________, Actual Purge ________
16. FEL No.'s Cond. ______ pH ______ Temp. ______ Redox ______
17.

Cond.	µmhos/cm	pH	Temp.	Redox mv
Initial	______	______	______	______
(Purged	______	______	______	______
cycle)	______	______	______	______
	______	______	______	______
Sample	______	______	______	______

    Sample Type and FEL No. ____________
18. [Y or N] Turbid ________, Purge Water Containerized ________
19. Sample Filtered ________, Filter Size ________
20. Reviewed By ____________ Date/Time ____________
    Form Complete? [Y or N] ______
    Decon Complete? [Y or N] ______

FIELD PROCEDURE FP 5-6

WELL PURGING - PUMPING METHOD

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Subject	Procedure No. FP 5-6	Rev. 0	Page 1 of 6
WELL PURGING - PUMPING METHOD	Issue Date 05/25/90		Effective Date 07/02/90
	Supersedes Procedure Number 630 FP 14	Rev. 0	Date
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to provide general reference information on well purging by the pumping method prior to the sampling of ground-water wells. The methods and equipment described are for the purging of water samples from the saturated zone of the substrata.

2.0 SCOPE

This procedure applies to. purging relatively large volumes of water in shallow to medium depth wells.

3.0 REQUIREMENTS

Methods for purging from completed wells include the use of pumps, compressed air, bailers, and various types of samplers. The primary considerations in obtaining a representative sample of the ground water are to avoid collection of stagnant (standing) water in the well and to avoid physical or chemical alteration of the water due to sampling techniques. In a non-pumping well, there will be little or no vertical mixing of water in the well pipe or casing, and stratification will occur. The well water in the screened section will mix with the ground water due to normal flow patterns, but the well water above the screened section will remain isolated and become stagnant.

4.0 REFERENCES

4.1 United States Environmental Protection Agency, 1987. *Ground Water Handbook*: EPA/625/6-87/016.

4.2 HAZWRAP, February 1989. *Quality Control Requirements for Field Methods*, DOE/HWP-69.

5.0 DEFINITIONS

None.

6.0 RESPONSIBILITIES

6.1 Project Manager

The Project Manager is responsible for reviewing the purging procedures used by the field crew and for performing in-field spot checks for proper purging procedures.

6.2 Site Hydrogeologist or Geochemist

The site Hydrogeologist or geochemist is responsible for selecting and detailing the specific well purging techniques and equipment to be used, documenting these in the project-specific work plan, and properly briefing the site sampling personnel.

6.3 Site Geologist

The Site Geologist is primarily responsible for the proper well purging techniques. When appropriate, such responsibilities may be performed by other qualified personnel (engineers, field technicians). The Geologist will be responsible for purging of wells, performing necessary physical measurements and observations, and containment of purged water. He must record pertinent information including amount of water purged, pH, specific conductivity, temperature, and turbidity in the Field Log Book and on the Ground-Water Sampling Form, Attachment 9.1.

7.0 EQUIPMENT

7.1 Gasoline or electric purge pump.

7.2 Power source.

7.3 Steel retractable engineer's measuring tape (Calibrated to 0.01 foot).

7.4 Water level indicators.

7.5 Swabbing equipment (as necessary).

7.6 pH meter.

7.7 Specific conductance meter.

7.8 Nephelometer.

7.9 Mercury thermometer.

7.10 HNu photoionization detector.

7.11 Drums to contain the development water.

7.12 Ground-water sampling form, Attachment 9.1.

7.13 Field log book.

8.0 PROCEDURE

8.1 General

- The amount of flushing a well should receive prior to sample collection will depend on the intent of the monitoring program and the hydrogeologic conditions.
- For the volumetric method, generally three to five well volumes are considered effective for purging a well.
- An alternative method of purging a well is to purge continuously (using a low volume low flow pump) while monitoring specific conductance, pH, and water temperature until the values stabilize.
- The site hydrogeologist, geochemist, and risk assessment personnel shall define the objective of the ground-water sampling program in the Work Plan.

8.2 Calculations of Well Volume

To ensure that the proper volume of water has been removed from the well prior to sampling, it is first necessary to determine the volume of standing water in the well pipe and the volume of water in the filter pack below the well seal. The volume can be easily calculated by the following method. Calculations shall be entered in the field logbook:

1. Obtain all available information on well construction (location, casing, screens, etc.).
2. Determine well or casing and borehole diameter.
3. Measure and record static water level (Depth below ground level or top of casing reference point), using one of the methods described in FP 7-2.
4. Determine depth of well (if not known from past records) by sounding, using a clean, decontaminated weighted tape measure.
5. Calculate number of linear feet of static water (total depth or length of well pipe minus the depth to static water level).
6. Calculate the volume of water in the casing and the volume of water in the filter pack.

$$Vc = \pi\ (di/2)^2\ (TD\text{-}H)$$

$$VF = \pi\ [(dH/2)^2 - do/2)^2]$$

TD - (S or H) (P)

If S > H use S, if S < H use H

$$Vt = (Vc + Vf)\ (7.48)$$

Where:

Vc	=	Volume of water in casing, ft^3
Vf	=	Volume of water in filter pack, ft^3
Vt	=	Total volume, gal
di	=	inside diameter of casing, ft
do	=	outside of diameter of casing, ft
dH	=	diameter of borehole, ft
TD	=	total depth of well, ft
H	=	depth to water, ft, from ground surface
S	=	depth to base of seal, ft, from ground surface
P	=	estimated porosity of filter pack (for most Ottawa, Morie #1 sand or glass beads this value is estimated at a range of 30 to 35%)

7. Determine the minimum number of volumes to be evacuated before sampling.

8.3 Specific Procedure

- To prevent cross contamination of wells, upgradient and background wells should be purged and sampled first.

- Open the well casing cover, remove the well cap and sample the well head space for gaseous contaminants using the HNu photoionization detector (see HNu instruction manual). If the organic vapor concentration is equal to or greater than 1000 ppm, immediately recap the well and inform the Field Operations Leader.

- Measure the "depth to water" in the well in accordance with the water level measurement procedure and using well construction data (FP 7-2).

- Calculate the volume of water in the well. Record this data in the purge notebook and calculate the volume of water in the well. Record this data in the purge notebook and calculate the volume of water required to be purged. Normally, the well will be purged of three to five volumes of water or until the temperature, pH and conductivity have stabilized.

- Lower the purge pump into the well until it is submerged. NOTE:!!! If resistance is encountered when lowering the pump into the well, WITHDRAW THE PUMP FROM THE WELL and inform the Field Operations Leader.

- Direct the pump discharge hose into the receptor bucket and start the pump in accordance with the pump's operation manual. Record the total volume of water purged from the well. Collect a minimum of three samples during purging and note the clarity of the sample, pH, conductivity, and temperature measurements of the sample in the purge notebook.

- Whenever the receptor bucket is filled, dispose of the purge water in accordance with the project-specific work plan.

- Continue purging the well until the required volume of water has been purged and physical parameters have stabilized.

- Carefully withdraw the purge pump from the well and decontaminate the pump and hose in accordance with FP 3-1.

- Dispose of all contaminated waste items in accordance with the project-specific work plan.

8.4 Well Purging by Pumping

Suction Pumps - There are many different types of inexpensive suction pumps including centrifugal, diaphragm, peristaltic, and pitcher pumps. Centrifugal and diaphragm pumps can be used for well evacuation at a fast pumping rate and for sampling at a low pumping rate. The peristaltic pump is a low volume pump (therefore not suitable for well purging) that uses rollers to squeeze a flexible tubing, thereby creating suction. This tubing can be dedicated to a well to prevent cross contamination. The pitcher pump is a common farm hand-pump.

These pumps are all portable, inexpensive and readily available. However, because they are based on suction, their use is restricted to areas with water levels within 20 to 25 feet of the ground surface.

- A significant limitation is that the volume created by these pumps can cause significant loss of dissolved gases and volatile organics.

- The complex internal components of these pumps may be difficult to decontaminate.

Submersible Pumps - Submersible pumps take in water and push the sample up a sample tube to the surface. The power sources of these samplers may be compressed gas or electricity. The operation principles vary and the displacement of the sample can be by an inflatable bladder, sliding piston, gas bubble, or impeller. Pumps are available for 2-in diameter wells and larger. These pumps can lift water from considerable depths (several hundred feet).

Limitations of this class of pumps include:

- Low delivery rates

- Many models of these pumps are expensive

- Compressed gas or electric power is required

- Sediment in water may cause clogging of the valves or eroding the impellers in some models

- Decontamination of internal components is difficult and time-consuming.

9.0 ATTACHMENTS

9.1 Ground-Water Sampling Form

ATTACHMENT 9.1
FP 5-5
2 PAGES

GROUND WATER SAMPLING FORM

3. GROUNDWATER SAMPLING FORM

1. Date/Time ______ Sample No. ______
2. Location ______
3. Well No. ______ Sketch on Back [Y or N] ______
4. Total Depth ______ Number of Screened Interval(s) ______
5. Depth to Screen/Length(s) ______
6. [Y or N] Well Secure? Comments ______
7. Sampler ______ Other present ______
8. Organic Vapor Detector FEL No. ______, Reading ______
9. Weather: Wind ______, Precipitation ______, Air Temperature ______
10. Water Level Measurement: FEL No. ______
    [Y or N] Well Labeled ______, Elev. Ref. For Water Level ______
    Comments ______
    Odor ______
11. Depth to Product ______ Depth to Interface/Water ______ Thickness ______
    1st
12. Casing Type ______, I.D. ______, Gal/Ft. ______
    (Show derivation for gal/ft of casing)
13. Total Depth ______ - Depth to Water ______ = Ht. ______
14. Well Volume ______ = Ht. ______ * Gal/Ft. ______
15. Required Purge Volume ______, Actual Purge ______
16. FEL No.'s Cond. ______ pH ______ Temp. ______ Redox ______
17.

Cond.	µmhos/cm	pH	Temp.	Redox mv
Initial	______	______	______	______
(Purged cycle)	______	______	______	______
	______	______	______	______
	______	______	______	______
	______	______	______	______
Sample	______	______	______	______

Sample Type and FEL No. ______

18. [Y or N] Turbid ______, Purge Water Containerized ______
19. Sample Filtered ______, Filter Size ______
20. Reviewed By ______ Date/Time ______
    Form Complete? [Y or N] ______
    Decon Complete? [Y or N] ______

FIELD PROCEDURE FP 5-7

MONITORING WELL AND BOREHOLE ABANDONMENT

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Subject	Procedure No.	Rev.	
	FP 5-7	0	Page 1 of 2
MONITORING WELL AND BOREHOLE ABANDONMENT	Issue Date: 05/25/90		Effective Date: 07/02/90
	Supersedes Procedure Number: 630 FP 33	Rev.	Date
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to describe, in general terms, the principles and methods of securing a monitoring well borehole from external contaminants after testing is completed.

2.0 SCOPE

This procedure applies specifically to abandonment of test holes and wells in the State of Ohio and generally to other locations with the understanding that federal, state or local regulations may modify these requirements. A specific plan for abandonment should be presented as an integral part of the monitoring well or borehole approval process.

3.0 REQUIREMENTS

The potential for entrance of contaminants into ground-water through monitoring wells or boreholes that are not properly maintained after testing is complete or simply abandoned, is enormous.

For this reason, an effective method for preventing the entrance of contaminants into ground water must be developed and utilized.

4.0 REFERENCES

4.1 Ohio Administrative Code (OAC) 3745-9-10, February 15, 1975, *Abandonment of Test Holes and Wells.*

5.0 DEFINITIONS

Contaminant - Any substance, which if introduced, would degrade the quality of ground water.

Grout - A slurry of cement, clay or other material impervious to and capable of preventing movement of water. Typically a neat cement grout containing three to five percent bentonite powder by weight.

6.0 RESPONSIBILITIES

The Field Operations Leader is responsible for assuring that monitoring wells and boreholes are abandoned in accordance with this procedure.

7.0 EQUIPMENT

7.1 Drilling Rig equipped with appropriate drilling tools and crew.

7.2 Cement, sand, bentonite powder, bentonite pellets or commercial hole-sealing products.

8.0 PROCEDURE

8.1 The client and regulatory agency shall determine if a monitoring well or borehole is damaged to the point of being useless or is no longer necessary for field investigations.

8.2 When abandoning a well containing walls, the well shall be filled with grout from the base of the well to the land surface by tremie pipe.

8.3 Test holes, dug with a backhoe to a relatively shallow depth to test the water level, shall ordinarily be filled with the material that was removed from the hole and compacted.

8.4 Wells with damaged casings shall be re-drilled to remove the casing and grouted. In this way, the integrity of the seal in the annular space; that is, between the side of the excavation and the casing, is assured. This method is also recommended in areas of potentially high contamination levels or where weather, especially frost heaving causes a void between the well apron and well casing.

9.0 ATTACHMENTS

None.

FIELD PROCEDURE FP 6-2

SURFACE WATER AND SEDIMENT SAMPLING

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Subject	Procedure No.	Rev.	
	FP 6-2	0	Page 1 of 10
SURFACE WATER AND SEDIMENT SAMPLING	Issue Date		Effective Date
	05/25/90		07/02/90
	Supersedes Procedure Number	Rev.	Date
	630 FP 29	0	
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to define the requirements necessary for surface water and sediment sampling. This procedure describes methods and equipment commonly used for collecting environmental samples of surface water and sediment samples for either on-site examination and testing or for laboratory analysis.

2.0 SCOPE

Surface water and sediment sampling is applicable to almost any site that has surface drainages on it or located hydraulically downgradient from it. The collection of concentrated sludges or hazardous waste samples from disposal or process lagoons often require methods, precautions and equipment different from those described herein. Consequently, specific sampling problems may require the adaptation of existing equipment or design of new equipment. Such innovations should be clearly described in the project-specific work plan.

3.0 REQUIREMENTS

Many factors must be considered in developing a sampling program for surface water or sediments, including study objectives; accessibility; site topography flow, mixing and other physical characteristics of the water body; point and diffuse sources of contamination; and personnel and equipment available to conduct the study. For waterborne constituents, dispersion depends on the vertical and lateral mixing within the body of water. For sediments, dispersion depends on bottom current or flow characteristics, sediment characteristics (density, size) and geochemical properties (which affect an adsorption/desorption). The hydrologist developing the sampling plan must know not only the mixing characteristics of streams and lakes, but also must understand the role of fluvial-sediment transport, deposition, and chemical sorption.

4.0 REFERENCES

4.1 Feltz, H.R., 1980. *Significance of Bottom Material Data in Evaluating Water Quality in Contaminants and Sediments*. Ann Arbor, Mich., Ann Arbor Science Publishers, Inc., V. 1, p. 271-287.

4.2 Kittrell, R.W., 1969. *A Practical Guide to Water Quality Studies of Steams.* U.S. Federal Water Pollution Control Administration, Washington, D.C., 135 p.

4.3 USEPA, 1980. *Standard Operating Procedures and Quality Assurance Manual.* Water Surveillance Branch, USEPA Surveillance and Analytical Division, Athens, Ga.

4.4 US Geological Survey, 1977. *National Handbook of Recommended Methods for Water-Data Acquisition.* Office of Water Data Coordination, USGS, Reston, Va.

5.0 DEFINITIONS

Environmental Sample - low concentration sample typically collected offsite and not requiring DOT hazardous waste labelling as a high hazard sample.

Hazardous Waste Sample - medium to high concentration sample (e.g., source material , sludge, leachate) requiring DOT labelling and Contract Lab handling as a high hazard sample.

6.0 RESPONSIBILITIES

6.1 Field Operations Leader

The Field Operations Leader has overall responsibility for the correct implementation of surface water and sediment sampling activities, including review of the sampling plan with, and any necessary training of, the sampling technician(s). The actual collection, packaging documentation (sample label and log sheet, chain-of-custody recorded, Contract Lab traffic reports, etc.) and initial custody of samples will be the responsibility of the sampling technician(s).

7.0 EQUIPMENT

1. Sampling bottles treated with preservatives if necessary
2. Specific conductivity meter
3. pH meter
4. Thermometer
5. Stainless steel bowl and spoon
6. Stainless steel hand auger, shovel, or spoon
7. Filtering equipment (needed if analyzing for metals in water)
8. Open tube
9. Dip sampler

10. Weighted bottle sampler
11. Hand pump
12. Kemmerer or Van Dorn Sampler
13. Depth-Integrating Sampler
14. Dredge

8.0 PROCEDURE

The following section outlines commonly used procedures for collecting surface water and sediment samples. Criteria for choosing the correct piece of sampling equipment is also covered in this section.

8.1 Water Sampling Techniques

8.1.1 Dip Sampling

Water is often sampled by filling a container, either attached to a pole or held directly, from just beneath the surface of the water (a dip or grab sample). Constituents measured in grab samples are only indicative of conditions near the surface of the water column and in the cross section. Therefore, whenever possible, one should augment dip samples with samples that represent both dissolved and suspended constituents and both vertical and horizontal distributions.

8.1.2 Weighted Bottle Sampling

A grab sample can also be taken using a weighted holder that allows a sample to be lowered to any desired depth, opened for filling, closed and returned to the surface. This allows discrete sampling with depth. Several of these samples can be combined to provide a vertical composite. Alternatively, an open bottle can be lowered to the bottom and raised to the surface at a uniform rate so that the bottle collects sample throughout the total depth and is just filled on reaching the surface. The resulting sample using either method will roughly approach what is known as a depth-integrated sample.

A closed weighted bottle sampler consists of a stoppered glass or plastic bottle, a weight and/or holding device, and lines to open the stopper and to lower or raise the bottle. The procedure for sampling is:

1. Gently lower the sampler to the desired depth so as not the remove the stopper prematurely (watch for bubbles).
2. Pull out the stopper with a sharp jerk of the sampler line.

3. Allow the bottle to fill completely, as evidenced by the cessation of air bubbles.

4. Raise the sampler and cap the bottle.

5. Decontaminate the outside of the bottle. The bottle can be used as the sample container (as long as the original bottle is an approved container).

8.1.3 Hand Pumps

Hand pumps may be operated by peristaltic, bellows, diaphragm, or siphon action. Hand pumps with operate by a bellow, diaphragm, or siphon action should not be used to collect samples which will be analyzed for volatile organics because the slight vacuum applied may cause loss of these contaminants. To avoid contamination of the pump, a liquid trap consisting of a vacuum flask or other vessel to collect the sample should be inserted between the sample inlet hose and the pump.

Tubing used for the inlet hose should be nonreactive (preferably Teflon). The tubing and liquid trap must be thoroughly decontaminated between uses (or disposed of after one use).

When sampling, the tubing is weighted and lowered to the desired depth. The sample is the obtained by operation of the pump and subsequently transferred from the trap to the sample container.

8.1.4 Kemmerer/Van Dorn Samplers

If samples are desired at a specific depth, and the parameters to be measured do not require a Teflon coated sampler, a Standard Kemmerer or Van Dorn sampler may be used. The Kemmerer sampler is a brass cylinder with rubber stoppers that leave the ends open while being lowered in a vertical position to allow free passage of water through the cylinder. The Van Dorn sampler is plastic and is lowered in a horizontal position. In each case a "messenger" is sent down the line when the sampler is at the designated depth, to cause the stoppers to close the cylinder, which is then raised. Water is removed through a valve to fill sample bottles.

8.1.5 Depth Integrated Sampling

Depth integration is used to collect a water and suspended material sample, in direct proportion to relative velocity at each increment of depth. This means that the volume of water and suspended material must enter the sample bottle at a rate proportional to the velocity of the flow passing the intake of the sampler. If a depth-integrating sampler is lowered from the surface to the bed and back at the same rate, and presuming that the sampler is not

overfilled during the course of the sampling operation, each increment of flow in that vertical is sampled proportionately to the velocity.

One method of collecting depth-integrated samples is equal-width-increment (EWI) technique. Samples are taken at several equally spaced intervals across the stream, with the transit rate of the sampler, that is the velocity at which the sampler is passed through the water column is the same in all verticals. The samples collected in each vertical are then composited into a single sample representative of the entire flow in the cross section. Since the volume collected in each vertical sample will be directly proportional to depth and velocity at the vertical location, the composite sample of the water-sediment mixture flowing in the cross section will be discharge-weighted.

The EWI method has several advantages: discharge measurements are not needed, the technique is learned easily, and the technique is applicable where cross-sectional stream flow distribution varies because of shifting beds or other causes. The main disadvantages are that the procedure is time consuming for large streams and does not provide quantitative information on cross-sectional discharge since this parameter does not need to be measured for the EWI method. Furthermore, the EWI method requires sampling at equally spaced verticals and the use of identical transit rates within each vertical.

In the equal-discharge-increment (EDI) technique, the positions of sampling vertical across the stream are based in incremental discharges rather than width (i.e., deeper or higher-velocity areas of the stream cross-section are sampled at a closer spacing). This method provides the most accurate measure of total discharge of the contaminant for streams which are not well mixed; however, it requires knowledge of the cross-sectional stream flow distribution.

The EDI method has several advantages: variable transit rates may be used because samples can be composited in proportion to known stream flow distribution, fewer verticals need to be sampled, and cross-section discharge information is obtained. The primary disadvantage of this method is that the streamflow distribution in cross section must be known or measured each time before sampling.

Because these multi-point sampling techniques can become very time-consuming and expensive, an alternate method often used involves sampling at the quarter points or other equal intervals across the width of the stream. Composites of individual samples collected at the quarter points can be fairly representative, providing the stream cross-section is properly located.

Several depth-integrating samplers specifically designed and suitable for collecting representative samples are available (contact: Engineer-in-Charge, Federal Inter-Agency Sedimentation Project, St. Anthony Falls Hydraulic Laboratory, Hennepin Island and 3rd Ave, SE Minneapolis, MN 55414; see also Reference 4.4 of this procedure). In shallow streams and wetlands that can be waded, the US DH-48 suspended-sediment sampler can be used. The US D-49 suspended-sediment sampler has also been used for many years to collect depth-integrated samples in large streams and rivers. It accommodates a 473-ml bottle and has a choice of nozzles (3.2-mm, 4.8-mm, and 8.4-mm in diameter) to control the rate of inflow of the water-sediment mixture. The D-49 sampler, which weighs about 27 kg, is suspended on a cable and operated with a reel attached to a boom. The US D-74 sampler is a modified D-49 sampler that accommodates either a 473-ml or 946-ml bottle. The US D-74 AL sampler is also a modified D-49 sampler, but is cast from aluminum and weighs approximately 13.6 kg. This sampler can be used with a handline in slower moving streams. The US DH-76 sampler is a modified DH-59 sampler that accommodates a 946-ml bottle and is available in the regular or trace-metal series. A new sampler, designated DH-80, accommodates either a 473-ml or 946-ml Mason jar. the intake nozzle with air exhaust ports is a single piece head molded from polypropylene. Contaminated heads can be replaced quickly and easily.

Because of the number and diversity of analyses which may be performed on collected surface water or water-sediment mixtures, a sample splitter will often be required. A churn splitter is a practical means for splitting composited samples into representative subsamples.

8.2 Sediment Sampling Techniques

Sediment samples are usually collected at the same verticals at which water samples were collected. If only one sediment sample is to be collected, the site should be approximately at the center of the water body. This is particularly true for reservoirs that are formed by the impoundment of rivers or streams. Generally, the coarser grained sediments are deposited near the headwaters of the reservoir. Bed sediments near the center will be composed of fine-grained materials which may, because of their lower porosity and greater surface area available for adsorption, contain greater concentrations of contaminants. The shape, flow pattern, bathymetry (depth distribution), and water circulation patterns must all be considered when selecting sediment sampling sites. In streams, areas likely to have sediment accumulation (bends, behind islands or boulders, quiet shallow areas or very deep, low-velocity areas) should be sampled while areas likely to show net erosion (high-velocity, turbulent areas) and suspension of fine solid materials should be avoided.

Chemical constituents associated with bottom material may reflect an integration of chemical and biological processes. Bottom samples reflect the historical input to streams, lakes, and estuaries with respect to time, application of chemicals, and land use. bottom sediments (especially fine-grained material) may help act as a sink or reservoir for adsorbed heavy metals and organic contaminants (even if water column concentrations are below detection limits). It is therefore important to minimize the loss of low-density "fines" during any sampling process.

8.2.1 Scoop Sampler

A scoop sampler consists of a pole to which a jar or scoop is attached. The pole may be made of bamboo, wood, or aluminum and be either telescoping or of fixed length. The scoop or jar at the end of the pole is usually attached using a clamp.

If the water body can be sampled from the shore or if it can be waded, the easiest and "cleanest" was to collect a sediment sample is to use a scoop sampler. This reduces the potential for cross-contamination. This method is accomplished by reaching over or wading into the water body and, while facing upstream (into the current), scooping the sample along the bottom in the upstream direction. It is very difficult not to disturb fine-grained materials of the sediment-water interface when using this method.

8.2.2 Core Samplers

Core samplers are used to sample vertical columns of sediment. They are useful when a historical record of sediment deposition is desired, for they preserve the sequential layering of the deposit. Coring devices are particularly useful for sediments because the "shock wave" created by descent is minimal, thus the fines at the sediment-water interface are not disturbed. Also, the sample is withdrawn intact, permitting the removal of only those layers of interest, and core liners manufactured of glass or Teflon can be purchased, thus reducing possible sample contamination. In addition, samples are easily delivered to the lab for analysis in the tube in which they are collected. The disadvantage of coring devices is that a relatively small surface area and sample size is obtained necessitating repetitive sampling to obtain large amounts of sample needed for some analyses.

Many types of coring devices have been developed to address varying depths of water from which the sample is to be obtained, the nature of the bottom material, and the length of the core to be collected. In shallow wadeable waters, the direct use of a glass or Teflon core liner is recommended. Teflon is preferred to avoid glass breakage and possible sample contamination from core barrels, cutting heads, and retainers.

Core sampler tubes or liners should be approximately 12" long since only recently deposited sediments (8" or less) are to be sampled. Soft or semi-consolidated sediments such as mud and clays have a greater adherence to the inside of the tube and thus can be sampled with large diameter tubes. However, because coarse or unconsolidated sediments such as sand and gravel will tend to fall out of the tube, a small diameter is required. A tube about 2" in diameter is usually sufficient. The wall thickness of the tube should be about 1/3" for either Teflon or glass. The end of the tube may be tapered by filing it down to facilitate entry of the liner into the substrate.

8.2.3 Hand Operated Gravity Corers

Hand corers are generally constructed of an outer rigid metal tube into which a 2 inch ID, plastic or Teflon core sleeve fits with minimal clearance. The cutting edge of the corer has a recessed lip on which the core sleeve rests and which accommodates a plastic core catcher. The core catcher is composed of intermeshing "fingers" that point upward into the core sleeve so that when the sampler is pressed into the sediment, the core is free to move past the catcher, but the core can not fall through the catcher upon removal of the sampler from the sediment.

Use of hand corers or liners involves pushing the device into the substrate until only 4 inches or less is above the sediment-water interface. When sampling hard or coarse substrates, a gentle rotation of the corer while it is pushed will facilitate greater penetration and cut down on core compaction. The liner is then capped with a Teflon plug or a sheet of Teflon held in place by a rubber stopper or cork. After capping, the corer is slowly extracted, the negative pressure and core catcher (if used) keeping the sample in the liner. As the bottom part of the liner comes out of the water, it too is capped. If the top or bottom of the liner contains water or air, the caps should be removed, the water carefully decanted (to avoid removal of surface sediments) and the ends packed with lean silica sand. The caps are then replaced and secured with friction tape. The orientation of the core should be marked on the sleeve.

Gravity corers are used to obtain sediment samples in water bodies deeper than 3 to 5 feet. These types of samplers can be used for collecting 1 to 2 foot cores (with a 2 inch ID) of surface sediments at depths of up to several hundred feet beneath the water surface. Because of their small diameter, gravity corers are not suitable for obtaining coarse-grained samples, but they are excellent for obtaining fine-grained materials.

The gravity core sampler operates in a manner similar to the hand operated core. A plastic or Teflon liner (2 inch ID) fits within a metal core housing fitted with a cutting edge. Core-catchers are used to retain the core within the liner. An opening exists above the liner to

allow free flow of water through the corer as it moves vertically through the water and into the sediment. The sampler has a messenger-activated valve assembly which seals the opening above the line following sediment penetration, which creates a partial vacuum to assist in sample retention during retrieval.

Samples are obtained by allowing the sampler, which is attached to sufficient length of stainless steel cable, to drop to the bottom. The weight of the sampler drives the core into the sediment to various depths depending on the characteristics of the sediments. The messenger is then dropped and the sampler carefully retrieved. Upon retrieval, treatment is similar to that described for hand corers.

8.2.4 Dredges

Dredges are generally used to sample sediments which cannot easily be obtained using coring devices (i.e., coarse-grained or partially-cemented materials) or when large quantities of materials are required. Dredges generally consist of a clam shell arrangement of two buckets. The buckets may either close upon impact or be activated by use of a messenger. Most dredges are heavy (up to several hundred pounds) and require use of a winch and crane assembly for sample retrieval. There are three major types of dredges: Peterson, Eckman and Ponar dredges.

The Peterson dredge is used when the bottom is rocky, in very deep water, or when the flow velocity is high. The dredge should be lowered very slowly as it approaches bottom, because it can force out and miss lighter materials if allowed to drop freely.

The Eckman dredge has only limited usefulness. It performs well where bottom material is unusually soft, as when covered with organic sludge or light mud. It is unsuitable, however, for sandy, rocky, and hard bottoms and is too light for use in streams with high flow velocities.

The Ponar dredge is a Peterson dredge modified by the addition of side plates and a screen on the top of the sample compartment. The screen over the sample compartment permits water to pass through the sampler as it descends, thus reducing the "shock wave" and permitting direct access to the secured sample without opening the closed jaws. The Ponar dredge is easily operated by one person in the same fashion as the Peterson dredge. The Ponar dredge is one of the most effective samplers for general use on all types of substrates. Access to the secured sample through the covering screens permits subsampling of the secured material with coring tubes or Teflon scoops, thus minimizing the chance of metal contamination from the frame of the device.

9.0 ATTACHMENTS

9.1 Surface/Water Sediment Sampling Form

SURFACE WATER/SEDIMENT SAMPLING FORM

1. Date/Time ______________________ Sample No. ______________________
2. Location ____
   ____
3. Sampler ____
4. Others Present ____
5. Organic Vapor Detector FEL No. ______________, Reading ______________
6. Weather: Wind ________, Precipitation ________, Air Temperature ________
7. FEL No.'s Cond. ________ pH ________ Temp. ________ Redox ________
8. Cond. Umhos/cm Sample ________ pH ________ Temp. ________ Redox ________
9. Dissolved Oxygen: (Circle One) Winkler or Meter
   (If Winkler, Show All Work)

   ____
   ____
   ____

   D.O. Meter FEL No. ____________, D.O. = ____________ ppm
10. Filtered Sample? ____________ Membrane Filter Size ____________
11. Flow ____________ Method ____________
12. Depth ____________ Bottom Type ______________________
13. Riparian Vegetation ______________________
14. Other Observations (Algae, Blooms, Etc.) ______________________
15. [Y or N] Turbid ______________________
16. Floating Solids or Liquids? ____________
17. Sample Type: Water ____________, Sediment ____________
    Depth of Sample: ____________

    Comments: ____
    ____
18. Reviewed By ______________________ Date/Time ______________________
    Form Complete? [Y or N] ____________
    Decon Complete? [Y or N] ____________

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FIELD PROCEDURE FP 6-3

SOIL SAMPLING

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Subject	Procedure No.	Rev.	
	FP 6-3	0	Page 1 of 6
	Issue Date		Effective Date
SOIL SAMPLING	05/25/90		07/02/90
	Supersedes Procedure Number	Rev.	Date
	630 FP 7	0	
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to outline the requirements for soil sampling. Soil sampling aids in defining the hydrogeological character of the substrata, or grid and the nature and extent of soil contamination. Soil samples are collected over an areal distribution as well as at different depths to characterize the on-site features.

2.0 SCOPE

Soil sampling is potentially applicable to any hazardous waste site. A variety of sampling techniques are available for collection of soil samples. These include: split-spoon sampling; collecting auger cuttings; Shelby tube sampling; pitcher barrel, pistol, or Dennison sampling; and single, double, and triple tube core barrel sampling. Split-spoon sampling is the most commonly used technique.

3.0 REQUIREMENTS

The collection point should be within 2 ft. horizontally of the identified location. The final location of the sampling point should be defined by surveying or measuring from previously surveyed points. The accuracy of the soil sampling point location will be determined by the data quality objectives.

Sample collection information should be recorded in the field logbook and in the sampling forms.

Surface/air contact may be minimized by placing the sample in an airtight container immediately after collection.

Sampling and sample preparation equipment will be decontaminated in accordance with the project-specific Work Plan prior to and after each sample is collected.

Soil sample locations shall be permanently identified using a brass surveyor's pin or equivalent permanent marker inscribed with the boring location identification set placed in a concrete marker, according to the project-specific Work Plan.

Soil samples with possible volatile organic analytes should be collected and containerized undisurbed (e.g. "California tubes"), if possible.

Depth-profile sampling must comply with the above requirements. Care must be taken to prevent cross-contamination and misidentification of samples.

Vertical depth control tolerances shall be specified in the project-specific Work Plan.

4.0 REFERENCES

4.1 HAZWRAP, February 1989. *Quality Control Requirements for Field Methods*, DOE/HWP-69, Rev. 0.

4.2 U.S. EPA, 1987, *A Compendium of Superfund Field Operation Methods.*

4.3 American Society for Testing Materials, Method D-1586-84. 1989. *Standard Method for Penetration Test and Split-Barrel Sampling of Soils.*"

5.0 DEFINITIONS

Thin-Walled Tube Sampler - A thin-walled metal tube (also called Shelby tube) used to recover relatively undisturbed soil samples. These tubes are available in various sizes, ranging from two to five inches O.D. and 18 to 54 inches long. A stationary piston device is included in the sampler to reduce sampling disturbance and increase sample recovery.

Split-Barrel Sampler - A steel tube, split in half lengthwise, with the halves held together by threaded collars at either end of the tube. Also called a split-spoon sampler, this device can be driven into resistant (consolidated) materials using a drive weight mounted in the drilling rig. A standard split spoon sampler (used for performing standard penetration tests) is two inches O.Dand 1 3/8 inches I.D. This standard spoon typically is available in two common lengths, providing either 20" or 26" internal longitudinal clearance for obtaining 18" or 24" long samples, respectively.

6.0 RESPONSIBILITIES

6.1 Field Operations Leader

The Field Operations Leader is responsible for overall management of field activities and ensuring that the appropriate sampling procedure is followed.

6.2 Site Geologist

The Site Geologist directly supervises the sampling procedure, classifies soil and rock samples, and directs the packing and sealing of soil and rock samples. Such duties may also be performed by geotechnical engineers, field technicians or other qualified field personnel.

7.0 EQUIPMENT

The following pieces of equipment may be needed to collect samples:

7.1 Drilling equipment, capable of collecting depth-specific samples.

7.2 Stainless steel hand auger, shovel, or post-hole digger.

7.3 Teflon™ tape.

7.4 Teflon™ or stainless steel spatula.

7.5 Stainless steel bowl or Teflon™ mixing board.

7.6 Organic vapor monitoring device (HNu or OVA)

7.7 Appropriate sampling containers.

7.8 Shelby tube sampling equipment.

7.9 Decontamination supplies as specified in the site-specific work plan.

7.10 Split spoon sampling equipment, either 1 7/8" or 2 1/2" I.D.

7.11 Field Logbook.

8.0 PROCEDURE

8.1 Split Spoon Sampling

Split barrel (spoon) samples are usually obtained in conjunction with hollow stem auger or rotary drilling techniques using either a 140 or 340 pound drive hammer (depending on the size of the sampler). The split spoon is attached to a metal rod and driven into the undisturbed soil ahead of the lead auger. The drive weight is raised 30 inches and dropped to hammer the split spoon into the ground. The hardness of the soil can be determined by extrapolating the number of blows of the hammer required to pound the split spoon into the soil six inches. The first six inches of penetration is considered a sealing drive. The number of blows for the second and third six inches is recorded to determine the penetration resistance. If, a specific interval is great enough to exceed 50 blow counts per six inches, spoon sampling will be discontinued at that interval and drilling will resume. The sampler will be advanced at least 18 inches or until refusal. The split spoon is retrieved from the borehole and opened with the air around the sample monitored with a HNu portable photoionization detector or other appropriate instrument. Samples for chemical analysis are taken with a stainless steel spoon or trowel, placed in a stainless steel bowl, homogenized and placed in the appropriate container. Large pebbles and cobbles should be excluded from samples taken for chemical analysis. Samples for lithologic description are collected and placed in the appropriate sampling jar or container. Lithologic samples are described according to the logging procedures.

Procedures for collecting split spoon samples are as follows:

1. Decontaminate the split-spoon sampler, liners and other sampling equipment according to Field Procedure FP 3-1.

2. If used, insert stainless steel, brass, and/or clear acetate liners into the split-spoon sampler. A typical arrangement of liner for a California type ring sampler are: two three-inch stainless steel liners, two three-inch brass liners and one six-inch brass. The liners should be inserted so the stainless steel sleeves are in the lead position.

3. Attach the split-spoon sampler to the bottom end of the drill rod string which extends from the top of the auger or borehole to the bottom of the borehole.

4. Attach a 340-pound (or other specified weight) hammer to the top of the drill rod string and drive the sampler into the soil at the bottom of the borehole. Record the hammer weight on the field log form.

5. To drive the sampler into the soil, alternately raise the hammer on a rope, which passes around a rotating cathead, and allow the hammer to free-fall 30 inches by suddenly releasing the tension on the rope.

6. Pull the sampler up from the bottom of the borehole by reversing direction of the rope on the cathead, and alternate applying and releasing pressure. Remove from the bottom of the drive rod string.

7. Remove the top assembly and the drive shoe from the sampler. Open the tube by removing one-half of the split barrel.

8. Immediately pass monitor for organic vapors with an OVA or HNu the length of the sample to detect organic vapors emanating from the sample.

9. Record the organic vapor readings in the Field Logbook.

10. Transfer soil selected for chemical analyses to its pre-labeled container as described in Steps 11 and 12 below.

11. For samples to be analyzed for volatile organic compounds (VOCs), trim the ends of one of the three-inch long brass liners, place a thin Teflon™ disk over each end of the liner, slip a plastic end cap onto each end, and tape the end caps in place. The entire brass liner is then labeled and shipped to the laboratory for volatile organics analyses.

12. For inorganic and nonvolatile samples, push the soil from the remaining liners, mix the soil on a Teflon™ board or in a stainless steel mixing bowl, and evenly subdivide it into the sample containers.

    NOTE: This mixing minimizes the heterogeneity of the soil samples and provides representative split and duplicate samples.

13. Describe the samples and record the description on the Field Logbook.

14. Verify that samples have been properly labeled and store on-site in a cooler at 4°C until they are packaged for shipping.

15. If sleeved samplers are not used, then the soil for volatile organic compound analysis must be collected immediately after the sampler is opened. This may be accomplished by cutting a strip of soil the entire length of the sample and placing in an appropriate container (usually a 40 mL VOA vial or 4 oz. glass jar). Soil should be perched in the container to minimize void spaces. Container should be sealed and placed on ice as soon as possible.

16. To minimize off-gassing of the volatiles, the sampler should not be driven until the sampling team is ready to accept and process the volatile portion.

17. This sampling procedure is repeated at each project-specific Work Plan specified interval throughout the borehole.

18. Upon completion of soil sampling activities, collect all spilled and excess material and place into lined waste disposal drums. Dispose of material in accordance with applicable regulations and any directives issued by the client, or as prescribed in the project-specific Work Plan.

19. All sampling equipment, including internal components, will be decontaminated prior to use, between sampling events, and prior to demobilization.

8.2 Undisturbed Soil Sampling

Undisturbed soil samples are collected using a thin-walled tube or Shelby tube sampler to recover relatively undisturbed soil samples suitable for laboratory tests. The thin-walled sampler is usually used to collect soil samples for physical tests such as porosity, permeability or grain-size. The construction of the tube and procedure used to collect samples preclude the use of this method for volatile organic or metal analysis.

A Shelby tube is a one piece hollow tube that is usually two to five inches outside diameter and five to 10 times the diameter in length. The sample tube is placed in the boring, on the bottom of the hole. The tube is pushed into the soil with a continuous and rapid motion without impact or twisting to a depth of between two and two 1/2 feet. The sampling tube is retrieved and the disturbed material is removed from the top of the tube. One inch of soil is removed from the base of the tube. An impervious disk is placed at both ends of the tube and sealed with a wax plug prior to shipment to the laboratory.

Sampling equipment should be decontaminated by following Field Procedure FP 3-1.

8.3 Hand Augured Sampling Methods

Decontaminated equipment will be used to collect the soil sample. A hand auger consists of a sample bucket attached to the bottom of a length of pipe that has a crossbar at the top. A hole is drilled by turning this crossbar at the same time the operator presses the auger into the ground. The hand auger is driven to the desired depth which is usually within a few feet of the surface. A stainless steel spool is used to obtain a sample. A relatively undisturbed soil sample should be obtained and containerized for volatile organics analysis.

Collect VOA samples by filling the sample container with soil, being careful to leave no headspace in the container. This sample should not be mixed since it is very important to obtain the VOA sample as quickly as possible to minimize the off-gassing.

Soil samples that are not to be analyzed for volatile organics are placed in a stainless steel bowl and homogenized with a stainless steel spoon or Teflon™ spatula. Large pebbles and cobbles should be removed from the sample. Collect composite samples for chemical analyses using appropriate containers.

Place the samples on ice in a cooler maintained at 4°C or below.

Note the sample identification, sample location (provide sketch), sampling time, and sampling personnel in the Field Logbook.

After auguring and sampling are completed, the borehole will be filled using a decontaminated shovel and excavated material from that hole. The ground surface will be restored to its original configuration.

Sampling equipment should be decontaminated by following procedures outlined in the project-specific Work Plan.

8.4 Continuous Core Sampling

Continuous core samples may be obtained by using the rotasonic drilling method or other appropriate continuous coring methods. Core samples should be scanned with an OVA or HNu photoionization detector and the levels recorded in the Field Logbook. Core samples showing high organic vapor content and physical evidence of contamination, such as soil discoloration, are potential sampling intervals. A relatively undisturbed sample is collected for volatile organics and placed in the container. The container is then sealed with Teflon™ tape. The soil is then placed in a stainless steel bowl, thoroughly mixed and then placed in a container to be subsampled for everything but volatile organics. Representative lithologic samples should be taken at selected intervals and placed into jars.

The sampling information is recorded in the Field Logbook and Sampling form. After a sample is collected, the sampling equipment is decontaminiated according to Field Procedure FP 3-1.

9.0 ATTACHMENTS

None.

FIELD PROCEDURE FP 6-4

DRUM HANDLING AND SAMPLING

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Subject	Procedure No. FP 6-4	Rev. 0	Page 1 of 19
DRUM HANDLING AND SAMPLING	Issue Date 05/25/90		Effective Date 07/02/90
	Supersedes Procedure Number 630 FP 8	Rev.	Date
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to provide general reference information for use in planning for and implementing sampling programs involving the moving and/or opening of closed containers on uncontrolled hazardous substance sites. Guidelines are provided for selecting containers to be opened and for moving and opening them. In addition, site organization, protective clothing, worker protection, and other safety procedures are discussed.

2.0 SCOPE

This guideline is applicable to opening and sampling of closed containers (120 gallon or less) on uncontrolled hazardous substance sites. Bulk tanks such as railroad tank cars, large above- and below-ground tanks (with a capacity of more than 120 gallons), and tank trailers are not considered in this procedure. Bulk tank removal is best handled through the procurement of a subcontractor (See Attachment 9.1)

3.0 REQUIREMENTS

Strict adherence to safety precautions cannot be overemphasized when handling and sampling drums. Hazards encountered when sampling drums include detonations, fires, explosions, vapor generation, and worker exposure to the waste. Scenarios involving drums encountered in the field may include drums that are unmarked, mislabeled, bulging, buried, deteriorated or leaking. Consequently, such drums may require handling to accommodate sampling. Because the condition of the drum and its contents dictate how drums are handled and sampled, no single procedure can be written to cover all possibilities. This procedure lists general guidelines that should be used when developing an on site drum handling/sampling procedure. The procedure developed should be based on all available information and revised as more information becomes available. When implementing the procedure, common sense and good judgement are paramount.

Consult OSHA regulations (29 CFR Sections 1910 and 1926) for established general requirements and standards for storing, containing, and handling chemicals and containers, and for maintaining equipment used for handling materials.

Consult EPA regulations (49 CFR 265) for requirements pertaining to the types of containers, maintenance of containers and containment structures, and design and maintenance of storage areas.

4.0 REFERENCES

4.1 NUS Corporation, 1983. *Operating Guidelines Manual.*

4.2 Cassis, J.A., et al., 1985. *Guidance Document for Cleanup of Surface Tank and Drum Sites*. Prepared for Office of Emergency and Remedial Response, USEPA, Washington, D.C. under Contract No. 68-01-6930.

4.3 *Hazardous Waste Operations and Emergency Response*, IT Corporation, Knoxville, TN., December 1988.

4.4 Martin, F.M., Lippitt, J.M., Prothero, T.G.; *Hazardous Waste Handbook for Health and Safety*, Butterworth Publishers, p. 167-177, 1987.

5.0 DEFINITIONS

Air Reactive Wastes - Some chemicals, such as white phosphorus or barium oxide, react with oxygen in the air, while others, such as sodium, cesium or various metal hydrides, react with the moisture or water vapor in the air. Many of these compounds are explosive when they come in contact with air or water.

Container - is defined as any drum, bottle, can, bag, etc., with a capacity of 120 gallons (450 liters) or less.

Glass Thief - a glass tube 4 ft. long and 3/4 inches in diameter, used for taking samples from drums. The tube is usually broken and disposed of in the drum following sampling.

Polyethylene or PVC-lined Drums - Often contains strong acids or bases. If the lining is punctured, the substance usually corrodes the steel, resulting in a significant leak or spill.

Exotic Metal Drums (i.e. aluminum, nickel, stainless steel, or other unusual metals) - Very expensive drums that usually contain an extremely dangerous material.

Single-Walled Drums Used as a Pressure Vessel - These drums have fitting for both product filling and placement of an inert gas, such as nitrogen. Such drums may contain reactive, flammable, or explosive substances.

Laboratory Packs - Such drums are commonly used for disposal of expired chemicals and process samples from laboratories, hospitals and similar institutions. Bottles in the lab pack may contain incompatible materials and may not be packed in absorbent material. They may contain radioisotopes, shock sensitive, highly volatile, highly corrosive, or very toxic exotic

chemicals. Laboratory packs are the primary ignition source for fires at most hazardous waste sites.

6.0 RESPONSIBILITIES

6.1 Field Operations Leader (FOL)

The Field Operations Leader is responsible for the overall safe conduct of the container opening and sampling operations. This includes informing and obtaining help from local authorities if necessary; selection of containers to open/sample; testing, moving, and staging of containers; container opening and sampling; resealing; and halting operations, including ordering site evacuation or requesting public evacuation (with help from local authorities) if necessary. The drum opening and sampling program will be planned in detail in the Project Specific Work Plan. If any unexpected results (e.g., explosions, atmospheric releases) occur, the FOL must inform the Project Manager immediately. Together with the Health and Safety Officer and outside assistance, if necessary, (e.g., EPA's Emergency Response Team), he must determine the most prudent course of action.

6.2 Health and Safety Officer (HSO)

The Health and Safety Office (HSO) is responsible for safety of all on-site operations, alerting the FOL of any potentially unsafe conditions, and halting work if on-site personnel or off-site public health is threatened.

6.3 Program Manager

The Program Manager is responsible for determining that opening and sampling of containers is necessary for the field investigation program, and the approximate numbers and types of containers to be opened.

7.0 EQUIPMENT

7.1 Spill control kit

7.2 Drum overpacks

7.3 Drum grappler

7.4 Drum opening equipment suitable for the respective type drums

7.5 Explosion meter

7.6 HNu portable organic vapor analyzer

7.7 Fire extinguisher, Class A, B and C, 12 lb. capacity

7.8 Alpha and beta radiation detector

7.9 Personal protective equipment as required by Health/Safety Plan which may include: Robar or Tingley boots, Tyvele protective suit with good, acid jacket and pants, vinyl booties,

vinyl sample gloves, nitrile outer gloves, hard hat with splash shield and supplied air respirator.

7.10 Plexiglass shield

7.11 Sheet plastic

7.12 Sampling equipment

8.0 PROCEDURE

8.1 General

The guidance presented is based on field experience in working with containers on uncontrolled hazardous substance sites. It will be evident that in many cases hard-and-fast rules cannot be given, and professional judgement is required because uncontrolled variables are involved. For example, no one can be absolutely certain of any assessment of the potential contents of a container. Labels cannot be absolutely trusted; only educated guesses can be made by a thorough review of all available background data, such as potential sources of the wastes.

Three basic risks are involved in moving and opening closed containers: (1) exposure of personnel to toxic materials, (2) fire, and (3) explosion. The first risk can be reasonably eliminated though the use of proper skin and respiratory protection equipment. The use of level A protection (i.e. totally encapsulated suit in conjunction with a self-contained breathing apparatus) acceptably reduces the risk of a worker being injured by toxic vapors, mists, or splashes. In the same way, standard fire prevention procedures can be used to reduce the fire hazard through the use of detector instruments and proper equipment. These include the use of nonsparking tools and intrinsically safe radios, pumps, and other equipment, as well as the staging of firefighting equipment and the elimination of any other possible ignition sources.

The explosive risk, however, is not as easily handled, and thus is the primary consideration in any container-opening operation. Even if no solid evidence of the presence of explosives is found during the preliminary data collection, one can never be certain that explosives have not been disposed of at the site. In order to provide the same reasonable level of protection against this risk as against toxic exposure and fire, a very cautious approach, such as the one recommended in this guideline, should be used.

8.2 Background Review

This section details the elements of a site background review necessary to prepare a Site Operations Plan for drum opening. The decision of whether or not to conduct the operation depends on the assessment of the site history. Therefore, it is important that the following tasks are completed thoroughly.

8.2.1 Preliminary Assessment

The preliminary assessment of existing data should be consulted in planning for a container-opening operation. Of special importance are items that can be used to characterize the types of hazardous materials present at the site (e.g., generator records, manifests, inventories, personal interviews, monitoring data). The review of all such data should search for the possible presence of shock-sensitive explosives and/or reactive chemicals. The absence of waste inventory information could prevent drum opening on the site without prior review.

8.2.2 Explosive Product Survey

If the site is a waste disposal or storage operation, a survey of commercial producers or users of explosives within the area served by the facility must be conducted. The determination of the area covered in this survey is a judgement that should be based on locations of known waste generators that used the facility and geographic location of the site. Agencies that could assist in identifying explosive producers or users are local and state police units, state transportation departments, the U.S. Department of Transportation (DOT), and EPA state hazardous-waste permit offices. Standard Industrial Classification (SIC) codes can be used to locate producers of explosives from lists of manufacturers available from state commerce agencies, local chambers of commerce, planning agencies, etc.

8.2.3 Site Inspection

A site visit is required prior to planning a drum opening operation. This visit may be in addition to the Reconnaissance Survey. Information on the following should be gathered during the inspection:

1. Site boundaries - fences, roads, natural boundaries, etc.
2. Access points and travel routes on the site.
3. Topographic features.
4. Adjacent land uses - residential, agricultural, public use areas, commercial establishments, schools, natural areas, etc.
5. Power lines, railroads, and public roads close to the site.
6. Container storage areas - provide observational details; describe if drums are jumbled, stacked, piled, arranged in rows, etc. General condition of drums indicates if containers can be grouped according to visual features, contents or any other classification method.
7. Buildings and other site structures, as well as any other disposal areas such as lagoons, landfills, surface piles, etc.

8. Location of water sources.

9. Location of potential staging areas.

In general, the preliminary assessment and site inspection should have been completed prior to involvement in opening and sampling drums. Field characterization should help to establish ambient conditions and identify potential hot spots. This information is to be plotted on the site sketch. Observations from maps and aerial photographs can also be used in compiling the site sketch.

During the site inspection phase, local officials should be contacted to arrange for fire protection and police support during the operation. Interviews should also be conducted with site workers, local officials, and any other people familiar with the site's history.

The central purpose of the background review is to evaluate the risk presented to personnel engaged in drum-opening operations. An assessment of drum contents is most important because it identifies specific risks. However, other site features also affect the hazard potential. Leaking and corroded drums, crowded and poorly organized conditions, and drums of unknown and apparently diverse origins are conditions that require careful planning.

There are no accurate quantitative methods available to evaluate the total danger. Assessment of the danger is subjective and should be done by personnel experienced in the field operations at hazardous sites. Good professional judgement is required, and project management must feel that adequate information is available to support a decision to conduct the drum-opening operations. Any positive indication of shock-sensitive materials that might react or explode requires special consideration. Sites that are suspected or known to contain such materials are to be referred to the Project Manager for planning for drum opening. In addition, sites that are judged to be unduly hazardous for any other reason should be referred to the Project Manager

8.3 Container Selection Considerations

The containers selected for opening and sampling will depend on the purpose of the operation and on considerations of safety--that is a container that may detonate is to be avoided. Even though many drums are found at uncontrolled disposal sites where the contents are unknown, it is worthwhile to consider drum markings and types, as well as drum groupings.

When considering sampling for enforcement, the first choice of drums would be those marked with known hazardous materials (trade name, chemical name, empirical formula) or hazardous labeling. Next would be those isolated be themselves or material contained in an exotic metal container (e.g., aluminum, nickel, monel, stainless steel). Then consideration

should be given to the unmarked drum piles or stacks. These should be sampled randomly among the various distinguishable drum lots.

When sampling for site characterization purposes, a concerted effort should be made to distinguish drum lots and to get a good drum count among the lots. A drum that appears to be characteristic and in the center of all the major drum lots should be sampled first, followed by drums in as many of the smaller lots as practical. Also, if practical, duplicate samples should be taken on major drum lots at either end of a lot to see if the wastes appear to be characteristic all the way through.

On most abandoned waste sites, there is some organization or pattern to the way the material was placed on the site. The pattern is occasionally as detailed as finding the flammable solvents in one area, acids in another, cyanide in another, recoverable metals in a fourth, and so on. Some disposal facilities stencil control numbers on drums to indicate specific lots. Often, if the site was poorly run, the only indication that a group of drums is related will be their color, size, or type.

Typically, waste is shipped to sites in 55-gal drums on trucks. About 60 to 80 drums are delivered from a given load, depending on the weight of the load. During the initial site inspection, one should look for distinguishing features in an attempt to define the different lots of drum on the site. Often the trade name, chemical name, or empirical formula will be written on the drum. Another distinguishing feature would be drums of exotic metal such as aluminum, nickel, monel, stainless steel, etc. A manufacturing facility will use a specified DOT coded drum, a strange drum size, or a drum with an unusual configuration or adaptation for a particular process line (center of drum head fill bung, double-sided fill/vent bungs, etc.).

At almost every site that has been receiving waste, there is an isolated group of containers. Approach these with care but do try to determine why they were segregated.

In any lot of drums there is sometimes encountered an unusual or out-of-place container. This oddball container will not fit the pattern, color, size, etc., of those around it (e.g., it may be the only distended drum among undistended drums or a lined drum among unlined drums).

An attempt should be made to avoid drums that are structurally damaged or if their movement or sampling would endanger a team member. Samples of drums in stacks or piles should not be taken if at all possible.

Before sampling any drums, an external radioactivity scan must be conducted with the results recorded in the field notebook. On a site where many different types of containers are

present, they should be sampled in the following order, based on what they can be expected to contain and in increasing order of hazard.

1. Paper, plastic, cloth, and burlap bags.
2. Glass carboys and jugs (except chemical reagent or laboratory-packed bottles).
3. Fiberboard drums.
4. Plastic and polyethylene carboys and containers.
5. Plastic-lined steel drums.
6. Steel drums.
7. Exotic metal drums.
8. Odd containers (distended, isolated, etc.).

Attachment 9.2 contains information of the types, sizes, DOT designation, openings, and recommended opening techniques for the various kinds of containers. Any drum without a DOT designation should be avoided, as it may have military origins. The DOT designation, which is usually found on the bottom of a drum, can be useful in determining the material of the drum.

8.4 Container Handling and Staging

Personnel involved in handling and transporting containerized waste shall work in teams containing no fewer than two people. Visual contact shall be maintained between members of the working team at all times. All team members shall be able to communicate between themselves and with the Site Health and Safety Officer by intrinsically safe two-way radio at all times on the work site.

Prior to physically handling a drum or other container, the following preliminary classifications checklist must be reviewed and each response noted in a field notebook:

1. Is the drum radioactive:
2. Does the drum exhibit leakage or deterioration, i.e., is it unsound?
3. Does the drum exhibit apparent internal pressure?
4. Is the drum empty?
5. Does the drum contain markings which would indicate that the contents are potentially explosive?

The results of the preliminary classification checklist dictate which specific procedures shall be followed in handling, opening, and sampling the drum.

The handling, movement, and transport of drums and other containers should be by use of mechanical equipment only; no drums should be handled manually. Remote drum handling equipment may consist of a grappler equipped backhoe or front-end loader. Drum transportation should be with front-end loaders or fork lifts with modified carrying platforms. Portions of equipment that contact drums or canisters should be constructed of non-ferrous metals or contact portions should be coated or lined to preclude spark generation. Handling and transport equipment must be equipped with full frontal and side splash and explosion shields. Class ABC fire extinguishers shall be fitted to the body of each piece of equipment.

When possible, drums or other containers to be sampled should be opened and sampled in place to minimize handling. However, when drums are stacked or are close together, they may have to be moved to prevent sympathetic detonation of, or chemical reaction with, other drums around the one being opened. The main criterion is distance to other drums--a reasonable distance should be maintained to keep the drum to be opened segregated from the others.

Drums or containers exhibiting the following characteristics require special treatment in handling and sampling:

- leaking or deteriorated drums
- bulging drums
- drums containing explosive or shock-sensitive waste
- drums containing radioactive waste
- lab packs
- gas cylinders

When drums are moved, they should be taken to a staging and sampling area that is diked or bermed to control any major spillage. Again, this area should be far enough away from other drums on the site to prevent a chain reaction. Only one container at a time should be placed in the staging area and opened. One crew can be moving and setting up the remote-opening equipment on the next container while another crew is sampling, labeling, and resealing the first container.

Containers that are inside warehouses, basements, or other buildings must be moved outside before they can be opened. Adequate ventilation is critical for container-opening operations.

Empty drums containing less than 1 in. of solid residual waste and those resulting from on-site bulking and repack operations shall be loaded by grappler into transport equipment and placed within the empty drum staging area. Residuals, where possible shall be transferred to repack containers prior to movement.

8.5 Remote Opening

Because of the possibility of encountering a drum containing a shock-sensitive material, any drum to be moved and/or sampled should be remotely shaken. On way of doing this is to carefully tie a rope around the drum and shake it from behind a barrier at a safe distance.

The required method of opening drums is by remote means (except as noted in Attachment 9.2). Three types of remote-opening equipment are available: the bung spinner, the remote-controlled drill, and the drum pierce.

The bung spinner consists of:

1. Air impact wrench with nonsparking adapter.
2. Drum-mounting bracket.
3. Two-stage regulator.
4. Compressed air cylinder with 100 ft of air hose and control valve.

The impact wrench is mounted over the bung on top of the drum by means of the steel-mounting bracket. The air tank, regulator, and control valve can be placed up to 100 ft away from the drum in a well-protected location.

A remote-controlled, air-operated, self-feeding, and self-retracting drill can also be used. This tool consists of:

1. Self-feeding and self-retracting drill.
2. Drum-mounting bracket.
3. 100 ft of air and control hoses.
4. Two-stage high-pressure regulator.
5. Compressed air cylinder.
6. Filter/regulator/lubricator unit.

As with the bung spinner, the air tank, regulator, and control valves can be placed up to 100 ft away from the drum in a well-protected location. There are two controls on this piece of equipment--a start valve and an emergency retract valve.

The drum pierce consists of:

1. Hydraulic ram with hand pump.
2. 100 ft of hydraulic hose.
3. Drum-mounting bracket (top or side).
4. Piercing nail.

This unit uses the same bracket as the drum drill. The hydraulic ram slowly forces the steel pierce through the drum surface as the hand pump is operated. When the 1/2 in. - diameter hole is complete, opening a relief valve on the pump allows the spring to retract the piercer from the hole.

When any of these pieces of equipment is used, the control lines are to be extended to their maximum, and drum-opening personnel are to operate the controls from behind sandbags, a concrete or brick structure, or other solid barriers. Remember, the opening surfaces of the drill or bung spinner should be decontaminated after each use.

The following guidelines are offered for other types of containers:

1. **Ring-closed, open-top drums** - Loosen the ring and then remove it remotely by means of a rope. If it is necessary to cut the ring, do so near the bolt or clamp/lever so that there will be a place to attach the rope.

2. **Glass carboys or jugs with lapped/ground-glass stopper or plastic cap** - Slowly release any retaining wire and vent any pressure. Remove the stopper or cap by hand only.

3. **Fiberpacks or corrugated cardboard containers** - Release the locking ring and remove the ring and lid by hand.

4. **Plastic or polyethylene carboys and plastic-lined drums (when necessary)** - Use a nonsparking aluminum, brass, or beryllium bung wrench of the proper size. Do not use a bung wrench on any distended drums of this type; remote methods will be applied.

5. **Plastic Kraft paper, burlap, or cloth bags** - Use a trowel or sampling trier. The bags should be resealed or placed in an overpack.

8.6 Problem Containers

Special handling techniques are required for containers which may expose personnel to particularly hazardous conditions. These techniques are describes in general below

(information derived from Reference 4.2), although site-specific conditions may require the development of specialized methods in the Site Operations Plan.

8.6.1 Leaking or Deteriorated Drums

1. The contents of drums that exhibit leakage or apparent deterioration such that movement will cause rupture (determined by the HSO) must immediately be transferred to a repack drum. Equipment, including transfer pumps used in the repack operation, must be of explosion proof construction.

2. Leaking drums containing sludges or semi-solids, drums that are structurally sound but which are open and contain liquid or solid waste, and drums which are deteriorated but can be moved without rupture must be immediately placed in overpack containers.

8.6.2 Bulging Drums

1. Drums which potentially may be under internal pressure, as evidenced by bulging, must be sampled in place. Extreme care shall be exercised when working with and adjacent to potentially pressurized drums.

2. Should movement of a pressurized drum be unavoidable, handle only be a grappler unit constructed for explosive containment. The bulging drum should be move only as far as necessary to allow seating on firm ground or it should be carefully overpacked.

3. Openings into pressurized drums shall be plugged and the bung holes fitted with pressure venting caps set at 5 psi release.

8.6.3 Drums Containing Explosive or Shock Sensitive Waste

1. If drums containing wastes that have been identified by sampling, or are suspected by visual examination to be explosive in nature are found, the Task Order Manager and the HSO must be notified immediately, before the drums are handled in any way.

2. If the Task Order Manager and the HSO approve handling of these drums, they shall be handled with extreme caution. Initial handling shall be by a grappler unit constructed for explosive containment. Drums shall be palletized prior to transport to a high hazard interim storage and disposal area.

3. If at any time during remedial activities, an explosive, pursuant to provisions of Title 18, U.S. Code, Chapter 40 (Importation, Manufacturer, Distribution, and Storage of Explosive Materials, 1975 Explosives List) is identified, it should be secured and the appropriate state and federal agencies notified.

4. Identification of an explosive substance during the course of a remedial action is usually based on the experience of the on-site personnel. Potentially explosive materials usually may be identified by their physical

characteristics -- texture, color, density, etc., as well as the way they are packaged or labeled. Most explosives are solids. In some cases they are packaged in water-tight containers to exclude water, while in other cases they are packaged wet to preclude explosion.

5. Prior to handling or transporting drums containing explosive wastes, personnel working in the area shall be removed to a safe distance (as determined by the HSO). Continuous contact with the communication base shall be maintained until handling or transporting operations are complete. An audible siren signal system, similar to that employed in conventional blasting operations, shall be used to signify the commencement and completion of explosive waste handling or transporting activities.

8.6.4 Drums Containing Radioactive Waste

1. Drums containing radioactive wastes shall not be handled until radiation levels have been determined by an initial field survey which is recorded in a field notebook. The survey shall include background levels, direct gamma readings and laboratory analysis of drum surface wipe samples.

2. Depending on the level of radiation encountered, handling and transport may require special shielding devices to protect personnel. Following handling and transport, equipment used shall be surveyed by the HSO and decontaminated to background levels prior to recommencing work. Surveys shall also be made of the ground surface in the vicinity of original drum storage to identify potential soil contamination by spilled or leaked radioactive waste. Prior to recommencing work in the area, radioactive soil areas shall be isolated to prevent tracking of radioactive contaminants about the site, and workers who entered the area should have their gloves and boots surveyed for radiation.

8.6.5 Packaged Laboratory Wastes (Lab Packs)

1. If drums known or suspected of containing discarded laboratory chemicals, reagents or other potentially dangerous materials in small volume, or individual containers are found, the Task Order Manager is to be notified immediately, before the drums or containers are moved or opened.

2. If the Task Order Manager and the HSO approve the handling of these containers, they shall be handled with extreme caution. Until otherwise categorized, they shall be considered explosive or shock-sensitive wastes. Initial handling shall be by a grappler unit constructed for explosive containment. Drums shall be palletized and overpacked if required prior to transport to the Lab Pack staging area for sorting, identification, repacking and/or stabilization.

3. Prior to handling or transporting Lab Packs from the existing drum area, personnel working in the immediate area shall be removed to a safe distance. Continuous contact with the communication base shall be maintained until handling or transporting operations are complete. An

audible siren signal system, similar to that employed in conventional blasting operations will be used to signify the commencement and cessation of Lab Pack handling or transporting activities.

8.6.6 Air Reactive Wastes

1. If the presence of air reactive substance is verified or even suspected, the material should be immediately segregated and transported to a separate high hazard interim storage and disposal area.

2. Air reactive wastes may be discovered during opening or sampling operations. Air reactive substances normally require special packaging. They may be stored under water or some other liquid to minimize air contact. They may also be found in sealed ampoules, corrugated drums, stainless steel canisters, or specially lined drums.

8.6.7 Gas Cylinders

1. Gas cylinders, when encountered, should be stored and disposed of on a special case basis depending on the integrity of the cylinders and type of substance they are expected to contain.

8.7 Container Sampling

8.7.1 Equipment

1. Personal protection equipment.

2. 500 ml, wide-mouth amber glass bottle with Teflon cap liner.

3. Uniquely numbered sample identification labels and tags, filled out and affixed to sample containers before sampling commences.

4. 4-ft. x 3/4-in. ID glass sampling thief.

5. Remotely operated opening device (see Section 8.5).

6. One gallon covered cans half-filled with absorbent (for off-site shipment only).

8.7.2 Sampling Procedures

All drums and mechanical equipment should be grounded prior to the commencement of sampling. If they bung or container lid can be removed, sample contained liquids using a glass thief, which shall then be broken and discarded within the barrel. A barrel that has a badly rusted bung, or that cannot be sampled as above, shall be safely entered with a hydraulic penetrating device operated remotely (see Section 8.5). All openings shall be plugged except during sampling operation.

The steps to be followed in sampling are as follows:

1. Record any markings, special drum conditions, and type of opening in the field notebook, on the sample log sheet, and, later, on the Chain-of-Custody form. Locate the general area on a sketch of the site.

2. Stencil and identifying number on the drums and record in logbook. Consult the sampling plan for identifications

3. Make certain that the drum/container is set on a firm base, preferably in a fully upright position.

4. Open the drum/container as described in Section 8.5 and Attachment 9.2.

5. Insert glass tubing almost to the bottom of the drum or until a solid layer is encountered. About 1 ft. of tubing should extend above the drum.

6. Allow the waste in the drum to reach its natural level in the tube. The cap the top of the sampling tube with a tapered stopper, ensuring liquid does not come into contact with stopper.

7. Carefully remove the capped tube from the drum and insert the uncapped end in the sample container. Release the stopper and allow the glass thief to drain completely into the sample container.

8. Deliver 100 to 250 ml of the sample (the sampling plan will specify the amount) to a clean, wide-mouth, 500-ml (1-pt) glass sample jar. If the sample is not free flowing and is taken through a bung opening, repeated sampling may be necessary.

9. Place the used sampling tube, along with paper towels or waste rags used to wipe up any spills, into an empty metal barrel for subsequent disposal. If glass tubing has been used, it may be broken and left inside the drum being sampled.

10. Clamp the sample container tightly and place prelabeled and tagged sample container in a carrier.

11. Replace the bung or lids or place plastic over the drum/container.

12. Measure the sample for radioactivity and record results in a field notebook. If the meter readings exceed 10 mRhr, notify the FOL immediately.

13. Fill out Chain-of-Custody Record and carefully pack samples. The finished package will be padlocked or custody-sealed for shipment to the laboratory. The preferred procedure includes the use of a custody seal across filament tape that is wrapped around the package at least twice. The custody seal (paper, plastic, or metal) is folded over and stuck to itself so that the only access to the samples is by cutting the filament tape

or breaking the seal to unwrap the tape. The seal is signed before the package is shipped.

14. Complete the appropriate traffic report. Drum samples are always considered to be high-hazard samples.

8.7.3 Sample Preservation and Packing Procedures for Drummed Waste Samples

1. No preservatives shall be used.
2. Place sample in a ziplock plastic bag.
3. Place each bagged container in a 1-gallon covered can containing absorbent packing material. Place lid on can.
4. Mark the sample identification number on the outside of the can.
5. Arrange for the appropriate transportation mode consistent with the type of hazardous waste involved.

8.8 Resealing and Siting Containers

All containers opened for sampling need to be resealed to prevent the escape of vapors and possible reactions from rainwater, air and so on. The resealing methods will depend on the opening methods used and include the following:

1. Replacing the bung, screw cap, etc.
2. Replacing the lid and retaining ring.
3. Placing the drum in an overpack (larger drum) when it cannot be resealed by any other method.
4. If a hole is drilled, use of a special rubber of plastic plug. A drum bonnet should be used to ensure that rainwater does not seep around the plug.

It is important to note that these resealing methods are for the purpose of preventing leakage from the container while it is in storage on the site. If the container is to be moved off the site, DOT regulations regarding transportation of drums must be complied with. These will generally require more rigorous sealing procedures.

Once the drum is sampled and resealed, it should be left where it cannot react with other containers on the site. For a small number of drums, the storage areas may be the staging and opening area. In any event, the sampled drums should be placed in an area away from other groups of containers on the site. The reason is that slowly progressing chemical reactions can start when a container is opened and the contents exposed to air or the disturbance caused by handling the drum. Such a reaction could take hours or even days to

occur. Another reason for the segregation and identification of drums for recovery is for use as evidence.

8.9 Public Evacuation/Alert Consideration

8.9.1 General

The potential need for evacuation of the site and surrounding area must be considered when the Site Operations Plan and Health and Safety Plan are developed. The HASP should describe the conditions requiring evacuations and the parties responsible for issuing ad enforcing an evacuation order. Several sit- specific factors influence the need for, and the extent of, the evacuation or alerting of the nearby off-site public. These factors include the following:

1. Proximity of residences, shopping or other commercial or business areas, factories, highways, railroads, and airfields or other transportation routes that may have to be evacuated. This information will be available from the background review and preliminary site inspections.

2. Proximity of other facilities that could be involved in, cause or propagate a fire, explosion, or toxic release on the site. This information will also be known from the background review and site inspection.

3. Presence of explosive, flammable, or volatile substances on the site. Some general indications of the types of hazards present may be provided by the background review and site inspection. The probability of encountering explosives (i.e., directly detonatable or shock-sensitive materials as opposed to explosive vapor-oxygen mixtures) will have been reduced by the screening procedures applied during earlier site evaluation. Preliminary assessment and site inspection may provide indications, or definite knowledge, that specific compounds presenting know flammability or toxicity hazards are in the containers. Of these known hazards, those having the greatest potential for atmospheric spread off the site should be used in estimating evacuation hazard distances as described below. For example, if several volatile toxic liquids, or toxic vapors, ar present, those having the greatest toxic potential in air, as measured by a Threshold Limit Value (TLV) or classified as Immediately Dangerous to Life and Health (IDLH), should determine the hazard distance, since these have the potential for the greatest health impacts.

   Atmospheric drift of a toxic or flammable vapor cloud or plume can often extend to great distances from the site, and hence potentially threaten more people than even an explosive hazard. Similarly, thermal-radiation hazards generated by even a large fire on the site generally reach to distances which are small compared to possible atmospheric drift distances of a vapor cloud.

4. Potential for an accident on the site which could result in an atmospheric release of flammable or toxic liquid or vapor. This possibility should be

remote if only one drum is opened at a time and if that drum is segregated from the other drums.

The most important parameter that needs to be established for any accident is the rate of liberation of flammable or toxic vapor; unfortunately, this is often the most uncertain quantity.

5. Prevailing wind speed and direction and atmospheric stability affect very strongly the pattern of atmospheric spread of a gas cloud. If these can be quantitatively estimated at the time an actual accidental release occurs, this information should be used in calculating an estimated evacuation corridor as detailed below.

   However, because wind direction is subject to rapid and unpredictable variations, and because atmospheric drift of a concentrated cloud or plume is greatest under stable atmospheric conditions and low winds speeds, it is usually preferable to take a conservative approach. Thus, one should base a public hazard evacuation distance, in any direction from the site, on an assumed worst-case atmospheric condition, that is, a stable atmosphere and nominal low wind speed, say 5 mph.

8.9.2 Plausible Accident Scenario

A plausible but hypothetical scenario for an accident that may be expected to occur during closed-container opening operations would involve a release, from only the one 55-gal drum being opened, of a volatile toxic liquid that rapidly vaporizes and forms and nonburning but continuous source of a toxic vapor plume. The rate of vapor generation and release can be calculated from the assumption that the upright drum is completely open at the top and a knowledge of the vapor pressure and some other readily available chemical properties of the chemical involved. For simplicity, the fact that a complex mixture of chemicals may actually be involved is neglected and the most toxic liquid or vapor is treated as if it were a pure component.

8.9.3 Estimating Hazard Evacuation Radius

Once the rate of atmospheric release of vapor is estimated for the accident scenario, outside assistance from any of several sources may be sought to estimate an atmospheric dispersion distance appropriate for the degree of flammability or toxicity hazard of the chemical involved. This estimate would then be used as a recommendation of an evacuation radius to be made to the responsible official in charge at the site, who will actually determine the necessity and extent of public evacuation.

Outside assistance in estimating the hazard radius in an emergency situation may be obtained from EPA's Emergency Response Team (ERT), the U.S. Coast Guard's Hazard Assessment Computer System (HACS), or from other hazard analysts.

Two different situations may require the evacuation of the off-site public:

1. The emergency resulting from an actual occurrence of an accident involving atmospheric release during drum-opening operations.

2. Precautionary planning before the start of drum-opening operations, in anticipation of an accident.

The above hypothetical scenario involving a single drum may be used in planning precautionary evacuations before the start of a dangerous drum-opening operation. On the other hand, in an actual accident, the release rate may be estimated if the number of drums releasing and the size of the opening in each such drum can be estimated by observation.

The decision to evacuate or alert the public off the site as a precautionary measure depends on the degree of hazard presented by the materials known to be present at the site. For the scenario described above, a table of numerical hazard distances for several of the commonly encountered chemicals and those expected to be found at the site will prepared before drum-opening commences as part of the Health and Safety Plan. These distances may then be used as numerical decision criteria for precautionary evacuation by comparing them to the known distances of populated areas from the site.

9.0 ATTACHMENTS

9.1 Provides reference information for procuring qualified subcontractors for drum handling and removal.

9.2 Techniques for opening containers.

DRUM HANDLING AND REMOVAL

1.0 PURPOSE

The purpose of this attachment is to provide reference information for procuring a qualified subcontractor for drum handling and removal activities at hazardous waste sites.

2.0 SCOPE

It is assumed that the removal and/or special onsite handling of drums at a hazardous waste site will require the services of a subcontractor specialist and that the lead firms within HAZWRAP will not undertake this activity themselves.

This attachment is limited to addressing the procurement of a qualified subcontractor for drum handling and removal activities.

3.0 REQUIREMENTS

Drum handling and removal is normally handled by specialty subcontractors. Specific contractural requirements are necessary to address this dangerous and sensitive activity.

4.0 REFERENCES

None.

5.0 DEFINITIONS

Drum - Any container used to store hazardous materials in a quantity less than 60 U.S. gallons.

Hazardous Materials - Any substance capable of producing deleterious health effects, upon any form of skin contact, inhalation or ingestion by animals or humans.

6.0 RESPONSIBILITIES

6.1 Project Manager

The Project Manger is responsible for identifying the need for procuring drum handling and removal services and for developing the bid package, technically reviewing bids and preparing the purchase requisition.

6.2 Field Operations Leader

The Field Operations Leader is responsible for monitoring the progress of the drum handling/removal subcontractor while the subcontractor is onsite, establishing that the subcontractor conforms to the requirements of the work scope.

7.0

None specified.

8.0 PROCEDURES

Information to be Transmitted to the Subcontractor

In preparing the bid package, the Project Manager shall provide all available information as related to the drum handling activity in question. The request shall make it a contractual requirements that the same information be transmitted by the main subcontractor to any lower-tier subcontractors who may be needed in order to complete the task.

The information shall include, but is not limited to, the following:

- general information and project/site background
- scope of work and proposed date(s) of activity
- waste characterization including:
  1. drum contents
  2. numbers of drums
  3. physical condition of drums
  4. physical description of drums
- Known chemical and physical hazards associated with the site and drums.
- Health, Safety and Training Requirements including, but not limited to the following:
- Health and Safety Plan (HASP) for the HAZWRAP Program which defines:
  1. Medical surveillance requirements for all subcontractor personnel. Prior to subcontractor personnel performing onsite work, each person must successfully complete, at subcontractor expense, the medical monitoring defined in the HASP and must provide the specified Physical Statement signifying medical approval to perform site work.
  2. Fundamental H&S Training (1 day) which is to be completed by the subcontractor's onsite employees prior to site work and which will generally be provided by the Health and Safety Officer (HSO) assigned to the site.
- Personal Protective Equipment requirements, which should be defined n the project specific HASP prepared by the HSO.
- Contract language requirements for the subcontractor to comply with all requirements of the Program HASP, the project-specific HASP, and all applicable Federal, State and Local Health and Safety regulations. Contract language should also specify that the HSO may stop the

subcontractor's work on his failure to comply with any of these requirements and that subsequent damages may be assessed.

8.2 Information Required to Evaluate the Subcontractor

The subcontractor and any lower-tier subcontractor to be used should be required to provide the following information as part of their bid:

- A complete case history regarding drum handling activities on hazardous waste sites and references regarding job performance
- Experience of specific subcontractor personnel who are to perform the drum handling activity in question
- A detailed description of equipment to be used for performing the scope of work

The bid package should request sufficient information from the bidders to permit the following considerations to be addressed:

- Experience and Reference

  1. How long has the subcontractor been in business?
  2. How many similar drum handling jobs has the subcontractor performed?
  3. Are references favorable?
  4. What is the experience of personnel specifically assigned to this project?
  5. Are the personnel in a current medical monitoring program?
  6. Is the subcontractor familiar with Health, Safety, Training, and Operational Procedures?

- Training

  1. Does the subcontractor have an employee training program?
  2. If so, how often is refresher training given?
  3. Are personnel certified or licensed by reputable agencies, associations?
  4. What does the training program encompass? Equipment operation? Health and Safety? Proper working procedures?

- Procedures

  1. Are the subcontractor's drum handling procedures consistent with EPA protocol, OSHA procedures, and other applicable standards?

2. Do these procedures account for:

   a. environmental stress?

   b. inclement weather?

   c. upgrading in the level of protection?

3. How does the subcontractor plan to carry out these procedures?

   a. how many operators?

   b. how many helpers?

   c. what are the specific responsibilities for assigned personnel?

- Equipment

1. Is the subcontractor's equipment:

   a. in conformance to OSHA standards?

   b. regularly inspected?

   c. regularly serviced?

   d. easily serviceable?

   e. modern?

2. Does the subcontractor employ:

   a. drum grapplers attached to a hydraulic excavator?

   b. a front-end loader, which can be loaded manually, equipped with a bucket sling, or used with a right terrain forklift?

3. Which of the aforementioned methods is better for the job?

4. Has the subcontractor proposed another acceptable method which is more feasible?

5. Has the subcontractor attempted to employ remote handling equipment that will lessen the potential for worker contact? Or is all work manual, presenting improper lifting and potential back injury concerns?

6. Does loading equipment contain:

   a. an air conditioned cab for operation safety and comfort?

b. an overhead canopy and safety splash shield for operation safety?

c. emergency escape packs if this is deemed necessary?

d. provision for use of supplied air respirators?

- Costs

Are costs:

1. Clearly outlined for the scope of work?

2. Responsible and competitive for the procedures and equipment being used?

These criteria should be cited as part of the detailed bid package for technical evaluation and selection of a drum handling subcontractor.

9.0 ATTACHMENTS

None.

ATTACHMENT 9.2
FP 6-4
3 PAGES

TECHNIQUES FOR OPENING CONTAINERS

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TECHNIQUES FOR OPENING CONTAINERS

Types	Size	DOT Designation	Type of Opening	Recommended Opening Technique
Steel drum, open head, unlined and lined	5-110G	DOT 5 - DOT 6 - DOT 17 - DOT 37 - DOT 42 -	Detachable steel lid with a clamp or lever-locking ring, or a ring with forged lugs and secured by a bolt.	Remove bolt. If possible, relieve pressure on clamp or lever-locking ring remotely (i.e., lanyard); Remove ring with lanyard. Remove lid by hand.
Steel drum, closed head, lined	5-110G	DOT 5 - DOT 6 - DOT 17 - DOT 37 - DOT 42 -	Plastic bung opening not larger than 2.3 in.	Preferred method is to remotely open bung. Manually open otherwise.
Steel drum, closed head, unlined (steel, monel, stainless, nickel, and aluminum)	5-110G	DOT 5 - DOT 6 - DOT 17 - DOT 37 - DOT 42 -	Steel or other metal bung not over 2.3 in.	Remote method.
Burlap bag, double Kraft paper bag, cloth bag, plastic bag	Various	DOT 36 - DOT 44 - DOT 45 -	Various.	Open with sharp implement; reseal bag or overpack in fiberpack.

TECHNIQUES FOR OPENING CONTAINERS (Cont'd)

Types	Size	DOT Designation	Type of Opening	Recommended Opening Technique
Glass carboys and jugs	6-20G	Usually DOT 1- branded into the wooden outer sheathing; often sheathing is no longer present.	Lapped or ground glass stopper; occasionally a plastic screw cap will be encountered.	Manually.
Laboratory reagent bottles (amber bottles), small reagent cans	Various	None	Screw top or press lid.	Usually encountered in lab packs. <u>Not to be handled or sampled</u>. Replace drum lid carefully. Contact ZPMO for action.
Polyethylene and other plastic drums or barrels	5-110G	DOT 2 -	Usually bung opening not over 2.7 in. in diameter.	Manually.
Gas cylinders	Various	DOT 3 - DOT 4 - DOT 8 - DOT 39 -	Valve, threaded fitting, quick-connect or puncture-type fittings.	<u>Not to be handled or sampled</u>. Contact ZPMO for action.
Fiberpack or corrugated	5-110G	DOT 12 - DOT 21 - DOT 23 -	Usually a detachable plastic lid with a clamp or lever-locking ring.	Manually remove locking ring and lid.

FIELD PROCEDURE FP 6-5

GROUND-WATER SAMPLING

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Subject	Procedure No. / Rev.	
	FP 6-5 / 0	Page 1 of 13
GROUND-WATER SAMPLING	Issue Date: 05/25/90	Effective Date: 07/02/90
	Supersedes Procedure Number: 630 FP 9 / Rev.: 0	Date:
Acceptance - Program QA	Approval - Program Manager	

1.0 PURPOSE

The purpose of this procedure is to obtain ground-water samples that are representative of the source from which they are taken, and minimize sampler exposure to ground-water contaminants. The methods and equipment described are for the collection of water samples from the saturated zone of the substrata.

2.0 SCOPE

This procedure provides information on proper equipment and techniques for ground-water sampling. Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling techniques. The techniques described should be followed whenever applicable, noting that site-specific conditions or project-specific work plans may require adjustments in methodology.

3.0 REQUIREMENTS

Generally, wells should be sampled within three hours of purging. However, wells with poor recharge should be sampled within 24 hours of purging. Poor recharge wells are those that cannot recharge 80% of the original volume within 8 hours.

Applicable preservatives must be added to the sample containers before receiving the samples. All sampling equipment must be decontaminated in accordance with Field Procedure FP 3-1, Decontamination of Sampling Equipment, before commencement of sampling.

4.0 REFERENCES

4.1 ASTM, 1986. *Annual Book of ASTM Standards*, Section 11. Volume 11.04, D4448-85A.

4.2 Barcelona, M.J., J.P. Gibb and R.A. Miller, 1983. *A Guide to the Selection of Materials for Monitoring Well Construction and Groundwater Sampling*, ISWS Contract Report 327, Illinois State Water Survey, Champaign, IL.

4.3 Johnson Division, UOP, Inc. 1975. *Ground Water and Wells, A Reference Book for the Water Well Industry*. Johnson Division, UOP, Inc., Saint Paul, MN.

4.4 Nielson, D.M. and G.L. Yeates, 1985. *A Comparison of Sampling Mechanisms Available for Small-Diameter Ground Water Monitoring Wells.* Ground Water Monitoring Review 5:38-98.

4.5 Scalf, M.R., J.F. McNabb, W.J. Dunlapp, R.L. Crosby and J. Fryberger, 1981. *Manual of Ground Water Sampling Procedures.* R.S. Kerr Environmental Research Laboratory, Office of Research and Development, USEPA, Ada, OK.

4.6 USDOE/HWP-69, 1989. *Quality Control Requirements for Field Methods.*

4.7 USEPA, 1980. *Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Facilities.* Office of Solid Waste, United States Environmental Protection Agency, Washington, D.C.

4.8 USEPA, 1986. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* EPA SW-846.

4.9 USEPA, 1987. *Ground Water Handbook,* EPA/625/6-87/016.

4.10 USEPA, 1987. *A Compendium of Superfund Field Operations Methods,* EPA/540/P-87/001.

5.0 DEFINITIONS

None.

6.0 RESPONSIBILITIES

6.1 Project Manager

Responsible for reviewing the sampling procedures used by the field crew and for performing in-field spot checks for proper sampling procedures.

6.2 Site Hydrogeologist or Geochemist

Responsible for selecting and detailing the specific ground-water sampling techniques and equipment to be used, documenting these in the project-specific Work Plan, and properly briefing the site personnel.

6.3 Site Geologist

The Site Geologist is primarily responsible for the proper acquisition of the ground-water samples. When appropriate, such responsibilities may be performed by other qualified personnel (engineers, field technicians).

7.0 EQUIPMENT

Sample containers shall conform with EPA regulations for preservation of appropriate contaminants (see Procedure FP 6-7).

Ideally, sample withdrawal equipment should be completely inert, economical, easily decontaminated, easily sterilized, reusable, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for well flushing and sample collection. The sample withdrawal equipment (evacuation devices) most commonly used are discussed in Section 8.3.2 of this procedure.

7.1 Sample Packing and Shipping Equipment.

7.2 Coolers for sample shipping and cooling.

7.3 Chemical preservatives.

7.4 Appropriate packing cartons and filler.

7.5 Labels.

7.6 Chain-of-custody documents.

7.7 Thermometer.

7.8 pH meter/paper.

7.9 Dissolved oxygen meter.

7.10 Portable HNu or OVA photoionization detector.

7.11 Specific-conductivity meter.

7.12 Camera and film.

7.13 Appropriate keys (for locked wells).

7.14 Tape measure.

7.15 Pipe wrenches.

7.16 Water-level indicator.

7.17 Flow meter.

7.18 Sample gloves.

7.19 Field sampling log books.

7.20 Knife.

7.21 Sample table and plastic cover.

7.22 Plastic trash bags.

7.23 Indelible pen.

7.24 Pen, black, permanent ink.

7.25 Shallow-well pumps: centrifugal, pitcher, suction, or peristaltic pumps with droplines, air-lift apparatus (compressor and tubing) where applicable

7.26 Deep-well pumps: submersible pump and electrical power generating unit, bladder pump with compressed air source, or air-lift apparatus where applicable

7.27 Sample tubing such as Teflon, polyethylene, polypropylene, or PVC. Tubing type shall be selected based on specific site requirements and must be chemically inert to ground water being sampled

7.28 Teflon, PVC, or stainless steel:

- Teflon-coated wire, stainless steel single strand wire, polypropylene monofilament line, or one-quarter inch nylon rope
- tripod-pulley assemble (if necessary)

7.29 Pails:

- Plastic, graduated

7.30 Decontamination Solutions:

- Distilled water, Alconox or Liquinox, methanol, acetone, or isopropyl alcohol

8.0 PROCEDURE

8.1 General

To be useful and accurate, a ground-water sample must be representative of the particular saturated zone of the substrata being sampled. The physical, chemical and bacteriological integrity of the sample must be maintained from the time of sampling to the time of testing in order to keep any changes in water quality parameters to a minimum.

The ground-water sampling program should be developed with reference to ASTM D4448-85A, Standard Guide for Sampling Ground Water Monitoring Wells. The ASTM guide is not intended as a monitoring plan or procedure for a specific application, but rather is a review of methods. Specific methods must be stated in the project-specific Work Plan.

Methods for withdrawing samples from completed wells include the use of pumps, compressed air, and various types of samplers such as bailers. The primary considerations in obtaining a representative sample of the ground water are to avoid collection of stagnant (standing) water in the well, and to avoid physical or chemical alteration of the water due to sampling techniques. In a non-pumping well, there will be little or no vertical mixing of water in the well pipe or casing. Stratification may occur. The well water in the screened section will mix with the ground water due to normal flow patterns, but the well water above the screened section will remain isolated and become stagnant. To safeguard against collecting non-representative stagnant water in a sample, the following approach should be followed during sample withdrawal:

1. All monitoring wells shall be pumped or bailed prior to withdrawing a sample. Evacuation of three to five volumes is recommended for a representative sample. In a high-yielding ground-water formation and where there is no stagnant water in the well above the screened section, evacuation prior to sample withdrawal is not as critical.

2. For wells that can be pumped or bailed to dryness with the sampling equipment being used, the wells should be evacuated and allowed to recover prior to sample withdrawal. If the recovery rate is fairly rapid and time allows, evacuation of more than one volume of water is preferred.

3. For high-yielding monitoring wells which cannot be evacuated to dryness, there is no absolute safeguard against contaminating the sample with stagnant water. One of the following techniques shall be used to minimize this possibility:

   a. The inlet line of the sampling pump should be placed just below the surface of the well water and three to five casing volumes of water pumped from the well at a rate equal to the well's recovery rate. This provides reasonable assurance that all stagnant water has been evacuated. The sample can then be collected directly from the pump discharge line, or a bailer can be used to collect the sample.

   b. The inlet line of the sampling pump (or the submersible pump itself) should be placed near the bottom of the screened section. Approximately one casing volume of water should be pumped from the well at a rate equal to the well's recovery rate. The sample should then be collected directly from the discharge line.

Stratification of contaminants may exist in the aquifer formation, either in terms of concentration gradients as a result of mixing and dispersion processes in a homogeneous layer, or due to layers of variable permeability into which a greater or lesser amount of the contaminant plume has flowed. Excessive pumping can dilute or increase the contaminant concentrations in the recovered sample compared to what is representative of the integrated water column at that point. This can result in the collection of a non-representative sample. Water produced during purging shall be collected, stored or treated and discharged as allowed. Disposition of purge water is usually project-specific and must be addressed in the project-specific Work Plan.

8.2 Calculations of Well Volume

To ensure that the proper volume of water has been removed from the well prior to sampling, it is first necessary to determine the volume of standing water in the well casing and the volume of water in the filter pack below the well seal. The volume can be easily calculated by the following method. Calculations should be entered into the field logbook:

1. Obtain all available information on well construction (location, casing, screens, etc.).

2. Determine well or casing and borehole diameter.

3. Measure and record static water level (depth below ground level or top of casing reference point), using one of the methods described in Field Procedure FP 7-2, Water Level Measurement.

4. Determine depth of well (if not known from past records) by sounding, using a clean, decontaminated, weighted tape measure.

5. Calculate number of linear feet of static water (total depth or length of well casing minus the depth to static water level).

6. Calculate the volume of water in the casing and the volume of water in the filter pack.

   $$Vc = (\pi)(di/2)^2(TD-H)$$

   $$Vf = (\pi)[(dH/2)^2-(do/2)^2](TD-[S \text{ or } H])(P)$$

   If $S > H$ use S, if $S < H$ use H

   $$Vt = (Vc+Vf)(7.48 \text{ gal/ft}^3)$$

   Where,

Vc	=	Volume of water in casing, ft^3
Vf	=	Volume of water in filter pack, ft^3
Vt	=	Total volume, gal
di	=	inside diameter of casing, ft
do	=	outside of diameter of casing, ft
dH	=	diameter of borehole, ft
TD	=	total depth of well, ft
H	=	depth to water, ft, from ground surface
S	=	depth to base of seal, ft, from ground surface
P	=	estimated porosity of filter pack (for most Ottawa, Morie #1 sand or glass beads this value is estimated at a range of 30 to 35%)
π	=	pi, a constant = 3.14

7. Determine the minimum number of volumes to be evacuated before sampling.

8.3 Evacuation of Static Water (Purging)

8.3.1 General

The amount of flushing a well should receive prior to sample collection will depend on the intent of the monitoring program and the hydrogeologic conditions. Programs to determine overall quality of water resources may require extended pumping periods to obtain

For defining a contaminant plume, a representative sample of only a small volume of the aquifer is required. These circumstances require that the well be pumped sufficiently to remove the stagnant water but not long enough to induce significant ground-water

An alternative method of purging a well is to pump continuously (usually using a low-volume, low-flow pump) while monitoring specific conductance, pH, and water temperature until the values stabilize.

The site hydrogeologist, geochemist and risk assessment personnel must define the objectives of the ground-water sampling program in the project-specific Work Plan, and provide appropriate criteria and guidance to the sampling personnel on the proper methods and volumes of well purging. Procedures for well purging are documented in Field Procedures FP 5-5, Well Purging - Bailing Method, and FP 5-6 Well Purging - Pumping Method.

8.3.2 Evacuation Devices

The following discussion is limited to those devices which are commonly used for sampling at hazardous waste sites.

Bailers are the most simple evacuation devices used and have many advantages. They generally consist of a length of pipe with either a ball check-valve at the bottom (most preferred), or the bucket-type bailer, which has a sealed bottom. An inert line (e.g., Teflon-coated) is used to lower the bailer and retrieve the sample.

Advantages of bailers include:

- Few limitations on size and materials used for bailers
- No external power source needed
- Bailers are inexpensive, and can be dedicated (secured in the well between sample collections) to reduce the chances of cross-contamination
- There is minimal outgassing of volatile organics while the sample is in bailer
- Bailers are relatively easy to decontaminate

Limitations on the use of bailers include the following:

- Removal of stagnant water is time consuming.
- Transfer of sample may cause aeration
- Use of bailers is physically demanding, especially in warm temperatures at protection levels above Level D.

Suction Pumps - There are many different types if inexpensive suction pumps including: centrifugal, diaphragm, peristaltic, and pitcher pumps. Centrifugal and diaphragm pumps may be used for well evacuation at both a fast pumping rate and low pumping rate. The peristaltic pump is a low volume pump (therefore not suitable for well purging) that creates a suction by using rollers to squeeze a flexible tubing. This tubing can be dedicated to a well to prevent cross contamination. The pitcher pump is a common farm hand-pump.

These pumps are all portable, inexpensive and readily available. However, because they are based on suction, their use is restricted to areas with water levels within 20 to 25 ft of the ground surface. Another significant limitation is that the vacuum created by these pumps can cause significant loss of dissolved gases and volatile organics. In addition, the complex internal components of these pumps may be difficult to decontaminate.

Gas-Lift Samplers

This group of samplers use gas pressure either in the annulus of the well or in a venturi to force the water through a sampling tube. The pumps are also relatively inexpensive. Gas lift pumps are more suitable for well development than for sampling, because the samples may be aerated, leading to pH changes and subsequent trace metal precipitation or loss of volatile organics. An inert gas such as nitrogen is generally used.

Submersible Pumps

The operating principles of submersible pumps vary widely. The displacement of the sample may be achieved by an inflatable bladder, sliding piston, gas bubble, or impeller. The power sources of these pumps maybe compressed gas or electricity. Pumps are available for 2-inch diameter wells and larger. These pumps can lift water from considerable depths (several hundred feet).

Limitations of this class of pumps:

- They may have low delivery rates
- Many models are expensive
- Compressed gas or electric power is required
- Sediment in water may cause clogging of the valves or abrading of the impellers
- Decontamination of internal components is difficult and time-consuming

8.4 Sampling

The sampling approach consisting of the following, should be developed as part of the project-specific Work Plan prior to the field work:

1. Background and objectives of sampling.
2. Brief description of area and waste characterization.
3. Identification of sampling locations, with map or sketch, and applicable well construction data (well size, depth, screened interval, reference elevation).
4. Sampling equipment to be used.
5. Assigned number, sequence volumes, and types of samples. If the relative degrees of contamination between wells is unknown or insignificant, a sampling sequence which facilitates sampling logistics may be followed. Where some wells are known or strongly suspected of being highly contaminated, these should be sampled last to reduce the risk of cross-contamination between wells as a result of the sampling procedures.
6. Sample preservation requirements.
7. Working schedule.
8. List of team members.
9. List of observers and contacts.
10. Other information, such as the necessity for a warrant or permission of entry, requirement for split samples, access problems, location of keys, etc.

8.4.2 Sampling Methods

The collection of a ground-water sample is made up of the following steps.

1. Set up the sample table adjacent to the well and cover the table top with clear sheet plastic to minimize contamination of the table. Tape the plastic onto the table and record the sample location, site, anticipated sample time, and field sample number onto the plastic using a indelible pen. Fill out sample labels for each of the required sample containers and place labels onto the appropriate sample containers. Labels must be waterproof to prevent water damage. The following information must be included on the sample label:

    - site name;
    - field identification or sample station number;
    - date and time of sample collection;

- designation of the sample as grab or composite;
- type of sample (matrix) and a brief description of the sampling location;
- printed full name of the sampler;
- sample preservative used; and
- types of analyses to be performed.

If a sample is split with another party, sample labels with identical information should be attached to each of the sample containers.

2. Position the labeled sample containers and required trip blanks, on the sample table so that the sampling information on the plastic is legible and take a photograph of the sampling setup.

3. Health and Safety Officer or designee will open the well cap and use volatile organic detection equipment (HNU or OVA) to monitor the escaping gases at the well head to determine the need for respiratory protection.

4. When proper respiratory protection has been selected and outfitted, sound the well for total depth and water level (using decontaminated equipment) and record these data in the field notebook. Calculate the fluid volume in the well according to Section 8.2.

5. Calculate depth from the casing top to the midpoint of the screen or well section open to the aquifer. Any dry wells encountered must be noted.

6. Select appropriate purging equipment. If an electric submersible pump with packer is chosen, go to Step 11.

7. Lower purging equipment or intake into the well to a short distance below the water level and begin water removal. If resistance is encountered when lowering the device into the well, **withdraw the device from the well** and inform the Field Operations Leader or use a smaller diameter device. Purge the well following the appropriate procedure (Field Procedures FP 5-5 Well Purging - Bailing Method, and FP 5-6 Well Purging - Pumping Method).

8. If sample is taken using a pump, lower the pump intake to midscreen or the middle of the open section in uncased wells and collect the sample. If sampling with a bailer, lower the bailer to sampling level before filling (this requires use of a bailer other than the "bucket-type"). Purged water should be collected in a designated container and disposed of in an acceptable manner according to the project-specific Work Plan.

9. (For pump and packer assemble only). Lower assembly into well so that packer is positioned just above the screen or open section, and inflate.

Purge a volume equal to at least twice the screened interval or unscreened open section volume below the packer before sampling. Packers should always be tested in a casing section above ground to determine proper inflation pressures for adequate sealing.

10. In the event that recovery time of the well is very slow (e.g., 24 hours), sample collection may be delayed until the following day. If the well has been bailed early in the morning, sufficient water may be standing in the well by the day's end to permit sample collection. If the well is incapable of producing a sufficient volume of sample at any time, take the largest quantity available and record in the logbook.

11. To ensure that ground-water samples are representative of actual conditions, samplers must work efficiently to minimize the loss of ground-water contaminants and the introduction of foreign contaminants. To prevent contamination of samples, the sample bottles should be opened only when receiving sample preservatives or ground-water samples and closed immediately afterwards. To prevent introduction of foreign contaminants into the well, sample bottles should be held away from the well opening when receiving samples and the bailing rope should not be allowed to touch the ground, or other potentially contaminating objects.

    The sampler should quickly add the sample into the sample containers, while minimizing aeration and loss of volatile contaminants. Samples collected for analysis of volatile constituents will be collected first, followed by samples collected for analysis of total organic carbon (TOC), total organic halogens (TOX), and those constituents which require field filtration or field determination after collection of volatile organics. Water from each bailer extraction from the well will be divided among the remaining sample bottles. For analysis that requires filtered samples, it is preferred that the samples be allowed to settle in a separate sample container, followed by decanting and then filtration. Consult the specific analytical procedure for details. Large volume samples for extractable organic compounds, total metals, etc., should be collected last.

    When a sample bottle is filled, the bottle must be tightly capped as soon as possible.

12. Efficiency and care must be utilized to obtain representative samples for volatile organic analysis. Unnecessary delays or poor sampling technique will lead to loss of the volatile constituents from the sample.

    Add the required preservatives to the sample containers within 12 hours of collecting the sample, label all containers and stage the collection setup before collecting the sample to minimize sampling time. If possible, collect samples using either a Teflon or stainless steel bottom filling bailer in accordance with Section 8.3.2. Prevent unnecessary stripping of volatile constituents from the sample by minimizing turbulence and aeration when filling the sample container. Quickly fill the sample container until a positive meniscus is achieved above the rim of the container and cap the container immediately. Gently tap the

sample container to dislodge any air bubbles and verify that no bubbles are present. If bubbles are detected, immediately uncap the sample, add additional sample from the bailer until a positive meniscus is re-established, immediately recap the sample and check the sample for bubbles. Repeat this step until the sample contains no bubbles and all required samples are obtained.

13. After sampling, replace the well cap.

14. As soon as all samples are collected, promptly prepare the samples for shipment in accordance with Field Procedure FP 6-7, Packaging and Shipment of Field Samples, and store the samples collected for volatile organic analysis in a cooler with prepackaged ice. Attach a custody seal to the shipping package as described in Field Procedure FP 6-7. Make sure that traffic reports and chain-of-custody forms are properly filled out and enclosed or attached (see Field Procedure FP 6-7).

15. Record all sampling information in the Field Sampling Log Book.

16. Decontaminate all equipment.

8.4.3 Sample Containers

For most samples and analytical parameters, either glass or plastic containers are satisfactory. Field Procedure FP 6-7, Packaging and Shipment of Field Samples, describes the required sampling containers for various analytes at various concentrations.

8.4.4 Preservation of Samples and Sample Volume Requirements

Sample preservation techniques and volume requirements depend on the type and concentration of the contaminant and on the type of analysis to be performed. Field Procedure FP 6-7 describes the sample preservation and volume requirements for most of the chemicals that will be encountered during hazardous waste site investigations.

8.4.5 Field Filtration

In general, preparation and preservation of water samples include some form of filtration. All filtration must occur in the field immediately upon collection. The recommended method is through the use of a disposable in-line filtration module (0.45 micron filter) using the pressure provided by the pumping device for its operation. Filters must be prerinsed with organic-free water.

Samples for organic analyses must never be filtered.

8.4.6 Handling and Transporting Samples

After collection, samples should be handled as little as possible. It is preferable to use self-contained "chemical" ice (e.g., "blue ice" to reduce the risk of contamination. If natural ice is used, it should be bagged and steps taken to ensure that the melted ice does not cause

sample containers to be submerged and thus the possibility of cross-contaminated. All sample containers should be enclosed in plastic bags or cans to prevent cross-contamination (see Field Procedure FP 6-7). Samples should be secured in the ice chest to prevent movement of sample containers and possible breakage. Sample packing and transportation requirements are described in Field Procedure FP 6-7.

8.4.7 Sample Holding Times

Holding times (i.e., allowed time between sample collection and analysis for routine samples are given in Field Procedure FP 6-7.

8.5 Records

Records will be maintained for each sample that is taken. The ground-water sampling form (Attachment 9.1) will be used to record the following information:

- Sample identification (site name, location, project number; sample name/number and location; sample type and matrix; time and date; sampler's identity).
- Sample source and source description.
- Field observations and measurements (appearance; volatile screening; field chemistry; sampling method).
- Sample disposition (analyses to be run; number and size of bottles; preservatives added).
- Additional remarks - (e.g., sampled in conjunction with state, county, local regulatory authorities; samples for specific conductance value only; sampled for key indicator; etc.).

8.6 Chain-of-Custody

Proper chain-of-custody procedures play a crucial role in data gathering. Field Procedure FP 6-7 describes the requirements for a correct chain-of-custody.

9.0 ATTACHMENTS

9.1 - Ground-Water Sampling Form

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ATTACHMENT 9.1
FP 6-5
2 Pages

GROUND-WATER SAMPLING FORM

3. GROUNDWATER SAMPLING FORM

1. Date/Time ______________ Sample No. ______________
2. Location ______________
3. Well No. ______________ Sketch on Back [Y or N] ______
4. Total Depth ______________ Number of Screened Interval(s) ______
5. Depth to Screen/Length(s) ______________
6. [Y or N] Well Secure? Comments ______________
7. Sampler ______________ Other present ______________
8. Organic Vapor Detector FEL No. ________, Reading ________
9. Weather: Wind ______, Precipitation ______, Air Temperature ______
10. Water Level Measurement: FEL No. ______________
    [Y or N] Well Labeled ______, Elev. Ref. For Water Level ______
    Comments ______________
    Odor ______________
11.

	Depth to Product	Depth to Interface/Water	Thickness
1st	______	______	______

12. Casing Type ________, I.D. ________, Gal/Ft. ________
    (Show derivation for gal/ft of casing)
13. Total Depth ________ - Depth to Water ________ = Ht. ________
14. Well Volume ________ = Ht. ________ * Gal/Ft. ________
15. Required Purge Volume ________, Actual Purge ________
16. FEL No.'s Cond. ______ pH ______ Temp. ______ Redox ______
17.

Cond.	µmhos/cm	pH	Temp.	Redox mv
Initial	______	______	______	______
(Purged	______	______	______	______
cycle)	______	______	______	______
	______	______	______	______
Sample	______	______	______	______

    Sample Type and FEL No. ______________
18. [Y or N] Turbid ________, Purge Water Containerized ________
19. Sample Filtered ________, Filter Size ________
20. Reviewed By ______________ Date/Time ________
    Form Complete? [Y or N] ________
    Decon Complete? [Y or N] ________

FIELD PROCEDURE FP 6-6

GRAIN SIZE ANALYSIS

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Subject	Procedure No. FP 6-6	Rev. 0	Page 1 of 4
GRAIN SIZE ANALYSIS	Issue Date 05/25/90		Effective Date 07/02/90
	Supersedes Procedure Number 630 FP 18	Rev. 0	Date
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to define the requirements necessary for the grain-size analysis of soils. The analysis of grain-size provides a quantitative measure of a soils grain-size distribution. Grain-size distribution is an important factor influencing a soils permeability, porosity, and the migration of ground water through an aquifer.

2.0 SCOPE

This procedure applies to the grain-size analysis of primarily sand and mud. The specific procedures include sieve and hydrometer analysis.

3.0 REQUIREMENTS

All grain-size analysis involve indirect methods of measuring size and are biased by the variable of shape (i.e., the length of the intermediate axis determines which grains pass through a sieve mesh) and in settling-tube analyses, by particle density as well. Consequently, care must be taken to compare only samples that do not differ markedly in grain shape and composition, and to ensure that disaggregation is complete.

4.0 REFERENCES

4.1 Lewis, D. W., 1984. *Practical Sedimentology*. Hutchinson Ross Publishing Company. pp 85-106.

4.2 Sanders, J.E., and Friedman, G. M., 1978. *Principles of Sedimentology*. John Wiley and Sons, 792 p.

4.3 *Standard Method for Particle-Size Analysis of Soils*, ASTM Method D-422-63, pp 116-126.

5.0 DEFINITIONS

Grain-Size - A term relating to the size of mineral particles that make up a rock or sediment.

Hydrometer - A tubular device made of glass with the lower end weighted, graduated in specific gravity, degrees API or other units, designed to determine the gravity of liquids by the

depth to which the hydrometer sinks when immersed.

6.0 RESPONSIBILITIES

6.1 Project Manager

The Project Manager is responsible for ensuring these procedures are included or referenced in the project-specific Work Plan.

6.2 Field Operations Leader

The Field Operations Leader is responsible for training the sampling technicians.

6.3 Field Technicians

The Field Technicians are responsible for conducting the actual grain-size analysis.

7.0 EQUIPMENT

7.1 **Balances** - A balance sensitive to 0.01g for weighing the material passing a No. 10 (2.00-mm) sieve, and a balance sensitive to 0.1% of the mass of the sample to be weighed for weighing the material retained in a No. 10 sieve.

7.2 **Stirring Apparatus** - Either a mechanically operated stirring device or air-jet dispersion cups.

7.3 **Hydrometer** - An ASTM hydrometer, graduated to read in either specific gravity of suspension or grams per liter of suspension.

7.4 **Sedimentation Cylinder** - Essentially a glass 1000 ml graduated cylinder, approximately 18 in. in height and 2-1/2 in. in diameter.

7.5 **Thermometer** - accurate to 1°F.

7.6 **Sieves** - It is best to obtain a full range of sieves when analyzing for a varied range of grain-sizes. Generally brass screens are used, however stainless steel screens are available. Common screen sizes used:

3 in. (75 mm)
2 in. (50 mm)
1-1/2 in (37.5 mm)
3/4 in. (19.0 mm)
3/8 in. (9.5 mm)
No. 4 (4.75 mm)
No. 10 (2.00 mm)
No. 20 (850 um)
No. 40 (425 um)
No. 60 (250 um)
No. 140 (106 um)

No. 200 (75 um)

7.7 **Water Bath or Constant Temperature Room** - Needed to maintain soil suspension at a constant temperature during hydrometer analysis <Temp. 68 - 70 F>

7.8 **250 ml Beaker**

7.9 **Timing Device** - Stop watch or clock/watch with a sweep second hand.

7.10 **Dispersing Agent** - Calgon, used for dispensing clays.

7.11 **Distilled or deionized Water**

7.12 **Oven** - Used for drying samples.

7.13 **Mechanical Shaker (Optional)** - Used in sieve analysis for shaking sediments through screens.

7.14 **Mortar and Pestle** - Used for disaggregating the sample.

7.15 **Field Logbook**

7.16 **Mason Jars** - For sample collection.

7.17 **Wash Bottle**

7.18 **Hand Lense or Bionuclear Microscope** - Useful for noting grain-shape attributes (roundness and angularity).

7.19 **Deionized Water/Distilled Water**

8.0 PROCEDURE

8.1 Sample Collection

- Choose samples to represent different lithologies encountered during drilling.
- To give statistically meaningful results, sample size should be large relative to the largest particle size present.
- Place samples in mason jars and label with monitoring well identification code, date, sample number, technician, and sample interval.
- Thoroughly mix samples before subsampling. Subsample size should be large relative to particle size.

8.2 Sample Analysis

Analysis of grain-size samples will be done in general accordance with ASTM Method D-422. Designation 422 covers the quantitative determination of the distribution of particle sizes in soils, using sieving and hydrometer techniques (see Attachment 9.1).

9.0 ATTACHMENTS

9.1 ASTM Procedures for Sieve and Hydrometer Analysis.

9.2 Data Sheet for Sieve Analysis.

9.3 Graph Paper for Plotting Grain-Size as a Histogram.

9.4 Arithmetic Paper for Plotting Grain-Size Distributions.

9.5 Probability Paper for Plotting Grain-Size Distributions.

ASTM PROCEDURES FOR PARTICLE SIZE ANALYSIS

4. DISPERSING AGENT

4.1 A solution of sodium hexametaphosphate (calgon) shall be used in distilled or demineralized water, at the rate of 40 g of sodium hexametaphosphate/litre of solution (Note 7).

NOTE 7 - Solutions of this salt, if acidic, slowly revert or hydrolyze back to the orthophosphate form with a resultant decrease in dispersive action. Solutions should be prepared frequently (at least once a month) or adjusted to pH of 8 or 9 by means of sodium carbonate. Bottles containing solutions should have the date of preparation marked on them.

4.2 All water used shall be either distilled or demineralized water. The water for a hydrometer test shall be brought to the temperature that is expected to prevail during the hydrometer test. For example, if the sedimentation cylinder is to be placed in the water bath, the distilled or demineralized water to be used shall be brought to the temperature of the controlled water bath; or, if the sedimentation cylinder is used in a room with controlled temperature, the water for the text shall be at the temperature of the room. The basic temperature for the hydrometer test is 68°F (20°C). Small variations of temperature do not introduce differences that are of practical significance and do not prevent the use of corrections derived as prescribed.

5. TEST SAMPLE

5.1 Prepare the test sample for mechanical analysis as outlined in Practice D 421. During the preparation procedure the sample is divided into two portions. One portion contains only particles retained on the No. 10 (2.00=mm) sieve while the other portion contains only particles passing the No. 10 sieve. The mass of air-dried soil selected for purpose of tests, as prescribed in Practice D 421, shall be sufficient to yield quantities for mechanical analysis as follows:

5.1.1 The size of the portion retained on the No. 10 sieve shall depend on the maximum size of particle, according to the following schedule:

Nominal Diameter of Largest Particles, in. (mm)	Approximate Minimum Mass of Portion, g
3/8 (9.5)	500
3/4 (19.0)	1000
1 (25.4)	2000
1-1/2 (38.1)	3000
2 (50.8)	4000
3 (76.2)	5000

5.1.2 The size of the portion passing the No. 10 sieve shall be approximately 115 g for sandy soils and approximately 65 g for silt and clay soils.

5.2 Provision is made in Section 5 of Practice D 421 for weighing of the air-dry soil selected for purpose of tests, the separation of the soil on the No. 10 sieve by dry-sieving and washing, and the weighing of the washed and dried fraction retained on the No. 10 sieve. From these two masses the percentages retained and passing the No. 10 sieve can be calculated in accordance with 12.1.

NOTE 8 - A check on the mass values and the thoroughness of pulverization of the clods may be secured by weighing the portion passing the No. 10 sieve and adding this value to the mass of the washed and oven-dried portion retained on the No. 10 sieve.

SIEVE ANALYSIS OF PORTION RETAINED ON NO. 10 (2.00-mm) SIEVE

6. PROCEDURE

6.1 Separate the portion retained on the No. 10 (2.00-mm) sieve into a series of fractions using the 3-in. (75-mm), 2-in. (50-mm), 1-1/2 in. (37.5-mm), 1-in. (25.0-mm) 3/4 in. (19.0-mm), 3/8 in. (9.5-mm), No. 4 (4.75-mm), and No. 10 sieves, or as many as may be needed depending on the sample, or upon the specifications for the material under test.

6.2 Conduct the sieving operation by means of a lateral and vertical motion of the sieve, accompanied by a jarring action in order to keep the sample moving continuously over the surface of the sieve. In no case turn or manipulate fragments in the sample through the sieve by hand. Continue sieving until not more than 1 mass % of the residue on a sieve passes that sieve during 1 min of sieving. When mechanical sieving is used, test the thoroughness of sieving by using the hand method of sieving as described above.

6.3 Determine the mass of each fraction on a balance. At the end of weighing, the sum of the masses retained on all the sieves used should equal closely the original mass of the quantity sieved.

HYDROMETER AND SIEVE ANALYSIS OF PORTION PASSING THE NO. 10 (2.00-mm) SIEVE

7. DETERMINATION OF COMPOSITE CORRECTION FOR HYDROMETER READING

7.1 Equations for percentages of soil remaining in suspension, as given in 14.3, are based on the use of distilled or demineralized water. A dispersing agent is used in the water, however, and the specific gravity of the resulting liquid is appreciably greater than that of distilled or demineralized water.

7.1.1 Both soil hydrometers are calibrated at 68 • F (20 • C), and variations in temperature from this standard temperature produce inaccuracies in the actual hydrometer readings. The amount of the inaccuracy increases as the variation from the standard temperature increases.

7.1.2 Hydrometers are graduated by the manufacturer to be read at the bottom of the meniscus formed by the liquid on the stem. Since it is not possible to secure readings of soil suspensions at the bottom of the meniscus, readings must be taken at the top and a correction applied.

7.1.3 The net amount of the corrections for the three items enumerated is designated as the composite correction, and may be determined experimentally.

7.2 For convenience, a graph or table of composite corrections for a series of 1 F temperature differences for the range of expected test temperatures may be prepared and used as needed. Measurement of the composite corrections may be made at two temperatures spanning the range of expected test temperatures, and corrections for the intermediate temperatures calculated assuming a straight-line relationship between the two observed values.

7.3 Prepare 1000 mL of liquid composed of distilled or demineralized water and dispersing agent in the same proportion as will prevail in the sedimentation (hydrometer) test. Place the liquid in a sedimentation cylinder and the cylinder in the constant-temperature water bath, set for one of the two temperatures to be used. When the temperature of the liquid becomes constant, insert the hydrometer, and, after a short interval to permit the hydrometer to come to the temperature of the liquid, read the hydrometer at the top of the meniscus formed on the stem. For hydrometer 151H the composite correction is the difference between this reading and one; for hydrometer 52H it is the difference between the reading and zero. Bring the liquid and the hydrometer to the other temperatures to be used, and secure the composite correction as before.

8. HYGROSCOPIC MOISTURE

8.1 When the sample is weighed for the hydrometer test, weight out an auxiliary portion of from 10 to 15 g in a small metal or glass container, dry the sample to a constant mass in an oven at 230 9 F (110 5 C), and weigh again. Record the masses.

9. DISPERSION OF SOIL SAMPLE

9.1 When the soil is mostly of the clay and silt sizes, weight out a sample of air-dry soil of approximately 50 g. When the soil is mostly sand the sample should be approximately 100 g.

9.2 Place the sample in the 250-mL beaker and cover with 125 mL of sodium hexametaphosphate solution (40 g/L). Stir until the soil is thoroughly wetted. Allow to soak for at least 16 h.

9.3 At the end of the soaking period, disperse the sample further, using a stirring apparatus. If stirring apparatus A is used, transfer the soil water slurry from the beaker into the dispersion cup, washing any residue from the beaker into the cup with distilled or demineralized water (NOTE 9). Add distilled or demineralized water, if necessary, so that the cup is more than half full. Stir for a period of 1 min.

NOTE 9 - A large size syringe is a convenient device for handling the water in the washing operation. Other devices include the wash-water bottle and a hose with nozzle connected to a pressurized distilled water tank.

10. HYDROMETER TEST

10.1 Immediately after dispersion, transfer the soil-water slurry to the glass sedimentation cylinder, and add distilled or demineralized water until the total volume is 1000 mL.

10.2 Using the palm of the hand over the open end of the cylinder (or a rubber stopper in the open end), turn the cylinder upside down and back for a period of 1 min. to complete the agitation of the slurry (Note 11). At the end of 1 min. set the cylinder in a convenient location and take hydrometer readings at the following intervals of time (measured from the beginning of sedimentation), or as many as may be needed, depending on the sample or the specification for the material under test: 2, 5, 15, 30, 60, 250, and 1440 min. If the controlled water bath is used, the sedimentation cylinder should be placed in the bath between the 2- and 5-min. readings.

NOTE 11 - The number of turns during this minute should be approximately 60, counting the turn upside down and back as two turns. Any soil remaining in the bottom of the cylinder during the first few turns should be loosened by vigorous shaking of the cylinder while it is in the inverted position.

10.3 When it is desired to take a hydrometer reading, carefully insert the hydrometer about 20 to 25 s before the reading is due to approximately the depth it will have when the reading is taken. As soon as the reading is taken, carefully remove the hydrometer and place it with a spinning motion in a graduate of clean distilled or demineralized water.

NOTE 12 - It is important to remove the hydrometer immediately after each reading. Readings shall be taken at the top of the meniscus formed by the suspension around the stem, since it is not possible to secure readings at the bottom of the meniscus

10.4 After each reading, take the temperature of the suspension by inserting the thermometer into the suspension.

11. SIEVE ANALYSIS

11.1 After taking the final hydrometer reading, transfer the suspension to a No. 200 (75-um) sieve and wash with tap water until the wash water is clear. Transfer the material on the No. 200 sieve to a suitable container, dry in an oven at 230 9 F (110 5 C) and make a sieve analysis of the portion retained, using as many sieves as desired, or required for the material, or upon the specification of the material under test.

CALCULATIONS AND REPORT

12. SIEVE ANALYSIS VALUES FOR THE PORTION COARSER THAN THE NO. 10 (2.00-mm) SIEVE

12.1 Calculate the percentage passing the No. 10 sieve by dividing the mass passing the No. 10 sieve by the mass of soil originally split on the No. 10 sieve and multiplying the result by 100. To obtain the mass passing the No. 10 sieve, subtract the mass retained on the No. 10 sieve from the original mass.

12.2 To secure the total mass of soil passing the No. 4 (4.75-mm) sieve, add to the mass of the material passing the No. 10 sieve the mass of the fraction passing the No. 4 sieve and retained on the No. 10 sieve. To secure the total mass of soil passing the 3/8-in. (9.5-mm) sieve, add to the total mass of soil passing the No. 4 sieve, the mass of the fraction passing the 3/8-in. sieve and retained on the No. 4 sieve. For the remaining sieves, continue the calculations in the same manner.

12.3 To determine the total percentage passing for each sieve, divide the total mass passing (see 12.2) by the total mass of sample and multiply the result by 100.

13. HYGROSCOPIC MOISTURE CORRECTION FACTOR

13.1 The hydroscopic moisture correction factor is the ratio between the mass of the oven-dried sample and the air-dry mass before drying. It is a number less than one, except when there is no hygroscopic moisture.

14. PERCENTAGES OF SOIL IN SUSPENSION

14.1 Calculate the oven-dry mass of soil used in the hydrometer analysis by multiplying the air-dry mass by the hygroscopic moisture correction factor.

14.2 Calculate the mass of a total sample represented by the mass of soil used in the hydrometer test, by dividing the oven-dry mass used by the percentage passing the No. 10 (2.00-mm sieve), and multiplying the result by 100. This value is the weight W in the equation for percentage remaining in suspension.

14.3 The percentage of soil remaining in suspension at the level at which the hydrometer is measuring the density of the suspension may be calculated as follows (Note 13): For hydrometer 151H:

$$P = [(100,000/W) \times G/(G - G_1)](R - G_1)$$

where:

a = correction faction to be applied to the reading of hydrometer 152H. (Values shown on the scale are computed using a specific gravity of 2.65. Correction factors are given in Table 1),

P = percentage of soil remaining in suspension at the level at which the hydrometer measures the density of the suspension.

R = hydrometer reading with composite correction applied (Section 7).

W = oven-dry mass of soil in a total test sample represented by mass of soil dispersed (see 14.2), g,

G = specific gravity of the soil particles, and

G_1 = specific gravity of the liquid in which soil particles are suspended. Use numerical value of one in both instances in the equation. In the first instance any possible variation produces no significant effect, and in the second instance, the composite correction for R is based on a value of one for G_1.

NOTE 13 - The bracketed portion of the equations for hydrometer 151H is constant for a series of readings and may be calculated first and then multiplied by the portion in the parentheses.

For hydrometer 152H:

$$P = (Ra/W) \times 100$$

where:

a = correction faction to be applied to the reading of hydrometer 152H. (Values shown on the scale are computed using a specific gravity of 2.65. Correction factors are given in Table 1).

P = percentage of soil remaining in suspension at the level at which the hydrometer measures the density of the suspension.

R = hydrometer reading with composite correction applied (Section 7).

W = oven-dry mass of soil in a total test sample represented by mass of soil dispersed (see 14.2), g.

G = specific gravity of the soil particles, and

G1 = specific gravity of the liquid in which soil particles are suspended. Use numerical value of one in both instances in the equation. In the first instance any possible variation producers no significant effect, and in the second instance, the composite correction for R is based on a value of one for G^1.

15. DIAMETER OF SOIL PARTICLES

15.1 The diameter of a particle corresponding to the percentage indicated by a given hydrometer reading shall be calculated according to Stokes' law (Note 14), on the basis that a particle of this diameter was at the surface of the suspension at the beginning of sedimentation and had settled to the level at which the hydrometer is measuring the density of the suspension. According to Stokes' law:

$$D = ([30n/980(G - G_1)] \times L/T)^{1/2}$$

where:

D = diameter of particle, mm.

n = coefficient of viscosity of the suspending medium (in this case water) in poises (varies with changes in temperature of the suspending medium),

L = distance from the surface of the suspension to the level at which the density of the suspension is being measured, cm. (For a given hydrometer and sedimentation cylinder, values vary according to the hydrometer readings. This distance is known as effective depth (Table 2)),

T = interval of time from beginning of sedimentation to the taking of the reading, min,

G = specific gravity of soil particles, and

G_1 = specific gravity (relative density) of suspending medium (value may be used as 1,000 for all practical purposes).

NOTE 14 - Since Stokes' law considers the terminal velocity of a single sphere falling in an infinity of liquid, the sizes calculated represent the diameter of spheres that would fall at the same rate as the soil particles.

15.2 For convenience in calculations the above equation may be written as follows:

$$D = K \ (L/T)^{1/2}$$

where:

K = constant depending on the temperature of the suspension and the specific gravity of the soil particles. Values of K for a range of temperatures and specific gravities are given in Table 3. The value of K does not change for a series or readings constituting a test, while values of L and T do vary.

15.3 Values of D may be computed with sufficient accuracy, using an ordinary 10-in. slide rule.

NOTE 15 - The value of L is divided by T using the A- and B- scales, the square root being indicated on the D-scale. Without ascertaining the value of the square root it may be multiplied by K, using either the C- or CI-scale.

16. SIEVE ANALYSIS VALUES FOR PORTION FINER THAN NO. 10 (2.00-mm) SIEVE

16.1 Calculation of percentages passing the various sieves used in sieving the portion of the sample from the hydrometer test involves several steps. The first step is to calculate the mass of the fraction that would have been retained on the No. 10 sieve had it not been removed. This mass is equal to the total percentage retained on the No. 10 sieve (100 minus total percentage passing) times the mass of the total sample represented by the mass of soil used (as calculated in 14.2). and the result divided by 100.

16.2 Calculate next the total mass passing the No. 200 sieve. Add together the fractional masses retained on all the sieves, including the No. 10 sieve, and subtract this sum from the mass of the total sample (as calculated in 14.2).

16.3 Calculate next the total masses passing each of the other sieves, in a manner similar to that given in 12.2.

16.4 Calculate last the total percentages passing by dividing the total mass passing (as calculated in 16.3) by the total mass of sample (as calculated in 14.2), and multiply the result by 100.

17. GRAPH

17.1 When the hydrometer analysis is performed, a graph of the test results shall be made, plotting the diameters of the particles on a logarithmic scale as the abscissa and the percentages smaller than the corresponding diameters to an arithmetic scale as the ordinate. When the hydrometer analysis is not made on a portion of the soil, the preparation of the graph is optional, since values may be secured directly from tabulated data.

18. REPORT

18.1 The report shall include the following:

18.1.1 Maximum size of particles.

18.1.2 Percentage passing (or retained on) each sieve, which may be tabulated or presented by plotting on a graph (Note 16).

18.1.3 Description of sand and gravel particles:

18.1.3.1 Shape - rounded or angular.

18.1.3.2 Hardness - hard and durable, soft, or weathered and friable.

18.1.4 Specific gravity, if unusually high or low.

18.1.5 Any difficulty in dispersing the fraction passing the No. 10 (2.00-mm) sieve, indicating any change in type and amount of dispersing agent, and

18.1.6 The dispersion device used and the length of the dispersion period.

NOTE 16 - This tabulation of graph represents the gradation of the sample tested. If particles larger than those contained in the sample were removed before testing, the report shall so state giving the amount and maximum size.

18.2 For materials tested for compliance with definite specifications, the fractions called for in such specifications shall be reported. The fractions smaller than the No. 10 sieve shall be read from the graph.

18.3 For materials for which compliance with definite specifications is not indicated and when the soil is composed almost entirely of particles passing the No. 4 (4.75-mm) sieve, the results read from the graph may be reported as follows:

(1)	Gravel, passing 3-in. and retained on No. 4 sieve	.... %
(2)	Sand, passing No. 4 sieve and reainted on No. 200 sieve	.... %
	(a).......Coarse sand, passing No. 4 sieve and retained on No. 10 sieve	.... %
	(b).......Medium sand, passing No. 10 sieve and retained on No. 40 sieve	.... %
	(c).......Fine sand, passing No. 40 sieve and retained on No. 200 sieve	.... %
(3)	Silt size, 0.074 to 0.005 mm	.... %
(4)	Clay size, smaller than 0.005 mm	.... %
	Colloids, smaller than 0.001 mm	.... %

18.4 For materials for which compliance with definite specifications is not indicated and when the soil contains material retained on the No. 4 sieve sufficient to require a sieve analysis on that portion, the results may be reported as follows (Note 17):

SIEVE ANALYSIS

Sieve Size	Percentage Passing
3 inches	....
2 inches	....
1-1/2 inches	....
1 inch	
1/4 inch	....
1/8 inch	....
No. 4 (4.75-mm)	....
No. 10 (2.00-mm)	....
No. 40 (425-um)	....
No. 200 (75-um)	....
	....

HYDROMETER ANALYSIS

0.074 mm	....
0.005 mm	....

0.001 mm ....

NOTE 17 - NO. 8 (2.36-mm) and No. 50 (300-um) sieves may be substituted for No. 10 and No. 40 sieves.

TABLE 1

VALUES OF CORRECTION FACTOR, α, FOR DIFFERENT SPECIFIC GRAVITIES OF SOIL PARTICLES[4]

Specific Gravity	Correction Factor[4]
2.95	0.94
2.90	0.95
2.85	0.96
2.80	0.97
2.75	0.98
2.70	0.99
2.65	1.00
2.60	1.01
2.55	1.02
2.50	1.03
2.45	1.05

4 For use in equation for percentage of soil remaining in pension when using Hydrometer 152H.

TABLE 2

VALUES OF EFFECTIVE DEPTH BASED ON HYDROMETER AND SEDIMENTATION CYLINDER OF SPECIFIED SIZES[A]

Hydrometer 151H		Hydrometer 152H			
Actual Hydro-meter Reading	Effective Depth, *L*., cm.	Actual Hydro-meter Reading	Effec-tive Depth, *L*., cm	Actual Hydro-meter Reading	Effec-tive Depth, *L*., cm
1.000	16.3	0	16.3	31	11.2
1.001	16.0	1	16.1	32	11.1
1.002	15.8	2	16.0	33	10.9
1.003	15.5	3	15.8	34	10.7
1.004	15.2	4	15.6	35	10.6
1.005	15.0	5	15.5		
1.006	14.7	6	15.3	36	10.4
1.007	14.4	7	15.2	37	10.2
1.008	14.2	8	15.0	38	10.1
1.009	13.9	9	14.8	39	9.8
1.010	13.7	10	14.7	40	9.7
1.011	13.4	11	14.5	41	9.6
1.012	13.1	12	14.3	42	9.4
1.013	12.9	13	14.2	43	9.2
1.014	12.6	14	14.0	44	9.1
1.015	12.3	15	13.8	45	8.9
1.016	12.1	16	13.7	46	8.8
1.017	11.8	17	13.5	47	8.6
1.018	11.5	18	13.3	48	8.4
1.019	11.3	19	13.2	49	8.3
1.020	11.0	20	13.0	50	8.1
1.021	10.7	21	12.9	51	7.9
1.022	10.5	22	12.7	52	7.8
1.023	10.2	23	12.5	52	7.6
1.024	10.0	24	12.4	54	7.4
1.025	9.7	25	12.2	55	7.3
1.026	9.4	26	12.0	56	7.1
1.027	9.2	27	11.9	57	7.0
1.028	8.9	28	11.7	58	6.8
1.029	8.6	29	11.5	59	6.6
1.030	8.4	30	11.4	60	6.5

TABLE 2 (Continued)

Hydrometer 151H				Hydrometer 152H	
Actual Hydro-meter Reading	Effective Depth, L., cm.	Actual Hydro-meter Reading	Effec-tive Depth, L., cm	Actual Hydro-meter Reading	Effec-tive Depth, L., cm
1.031	8.1				
1.032	7.8				
1.033	7.6				
1.034	7.3				
1.035	7.0				
1.036	6.8				
1.037	6.5				
1.038	6.2				

A Values of effective depth are calculated from the equation:

$$L = L_1 + 1/2\,[L_2 - (V_B/A)]$$

where:

L = effective depth, cm.
L_1 = distance along the stem of the hydrometer from the top of the bulb to the mark for a hydrometer reading, cm.
L_2 = overall length of the hydrometer bulb., cm.
V_B = volume of hydrometer bulb, cm^3, and
A = cross-sectional area of sedimentation cylinder, cm^2.

Values used in calculating the values in Table 2 are as follows For both hydrometers, 151H and 152H:

L_2 = 14.0 cm
V_B = 67.0 cm^3
A = 27.8 cm^3

For hydrometer 151H:

L_1 = 10.5 cm for a reading of 1.000
= 2.3 cm for a reading of 1.031

For hydrometer 152H

L_1 = 10.5 cm for a reading of 0 g/litre
= 2.3 cm for a reading of 50 g/litre

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ATTACHMENT 9.2
FP 6-6
5 PAGES

- Data Sheet for Sieve Analysis
- Graph for Plotting Grain-Size as a Histogram
- Arithmetic Paper for Plotting Grain-Size Distributions
- Probability Paper for Plotting Grain-Size Distributions

DATA SHEET FOR SIEVE ANALYSIS

Sample no. ______ Analysed by ________ Treatment ____,_____ Date ____________

Particulars ____

Weights : dry sample ______ sand ______ mud _______ sand & mud ___________

sieve diam. Ø	exact diam. Ø	weight beaker	weight beaker and sample	weight sample	% aggs.	corr-ected weight	cumul-ative weight	cumul-ative %	% shell	notes
-5.00										
-4.00										
-3.00										
-2.50										
-2.25										
-2.00										
-1.75										
-1.50										
-1.25										
-1.00										
-0.75										
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+3.00										
+3.25										
+3.50										
+3.75										
+4.00										
+4.25										
+4.50										
+4.75										
pan										
Total										

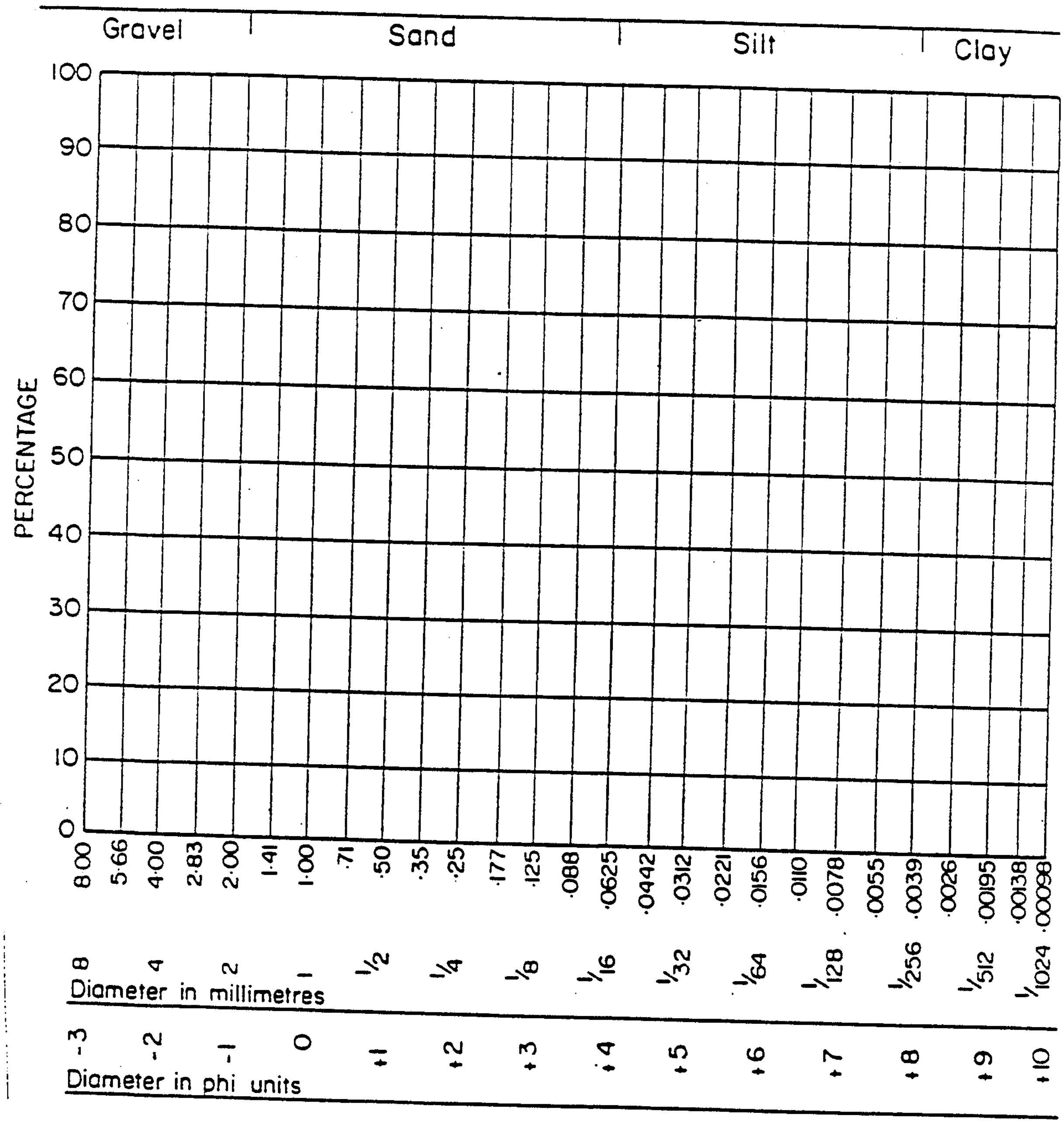
$$\text{Percent error} = \frac{(\text{original sample weight} - \text{total weight retained}) \times 100}{\text{original weight}}$$

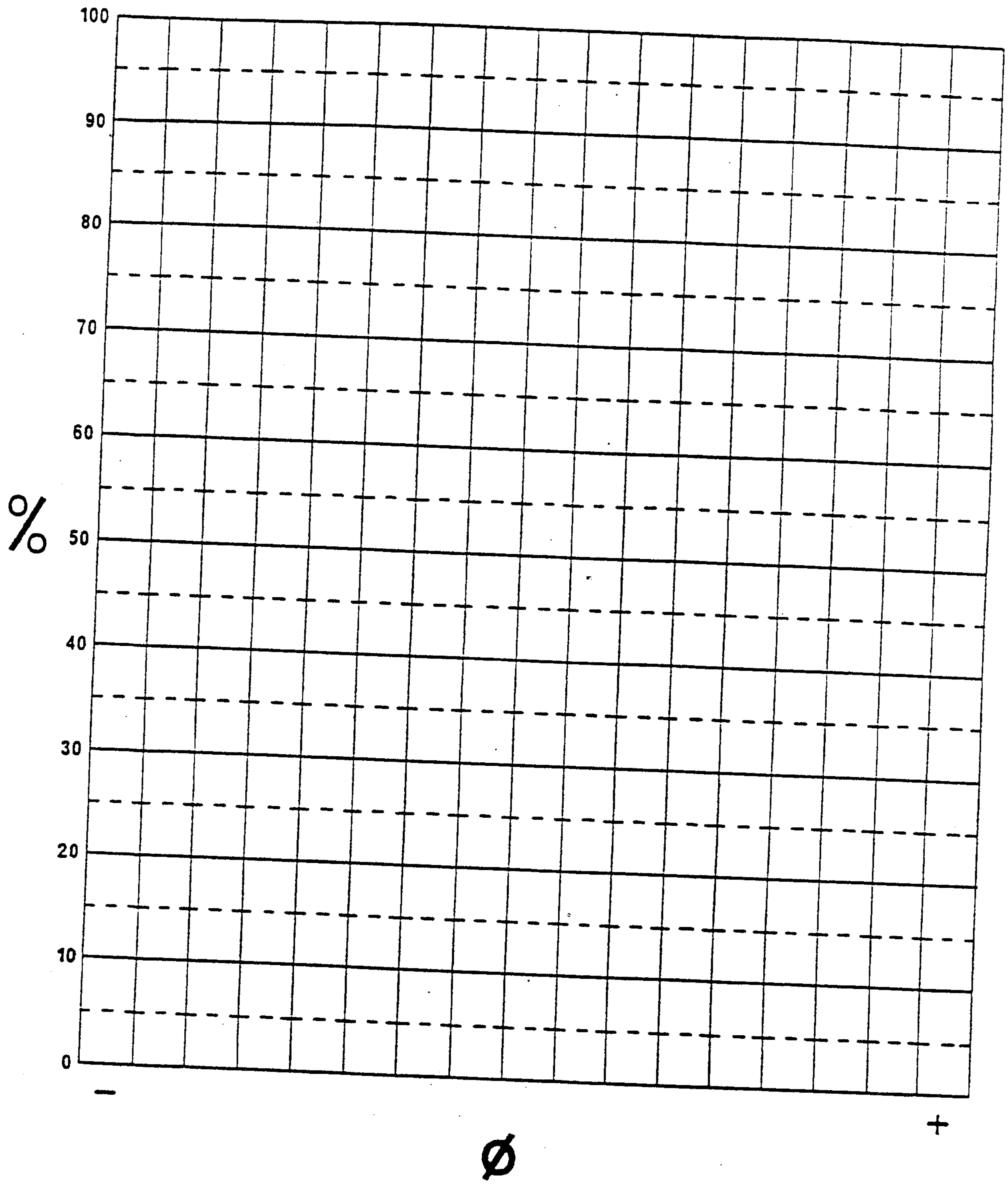
Sample no. ____________ Analyst ____________ Date ____________

Description of sample ____

Modal grade: ________ to ________ mm. Secondary modes: ________ to ________ mm.

________ to ________ mm.

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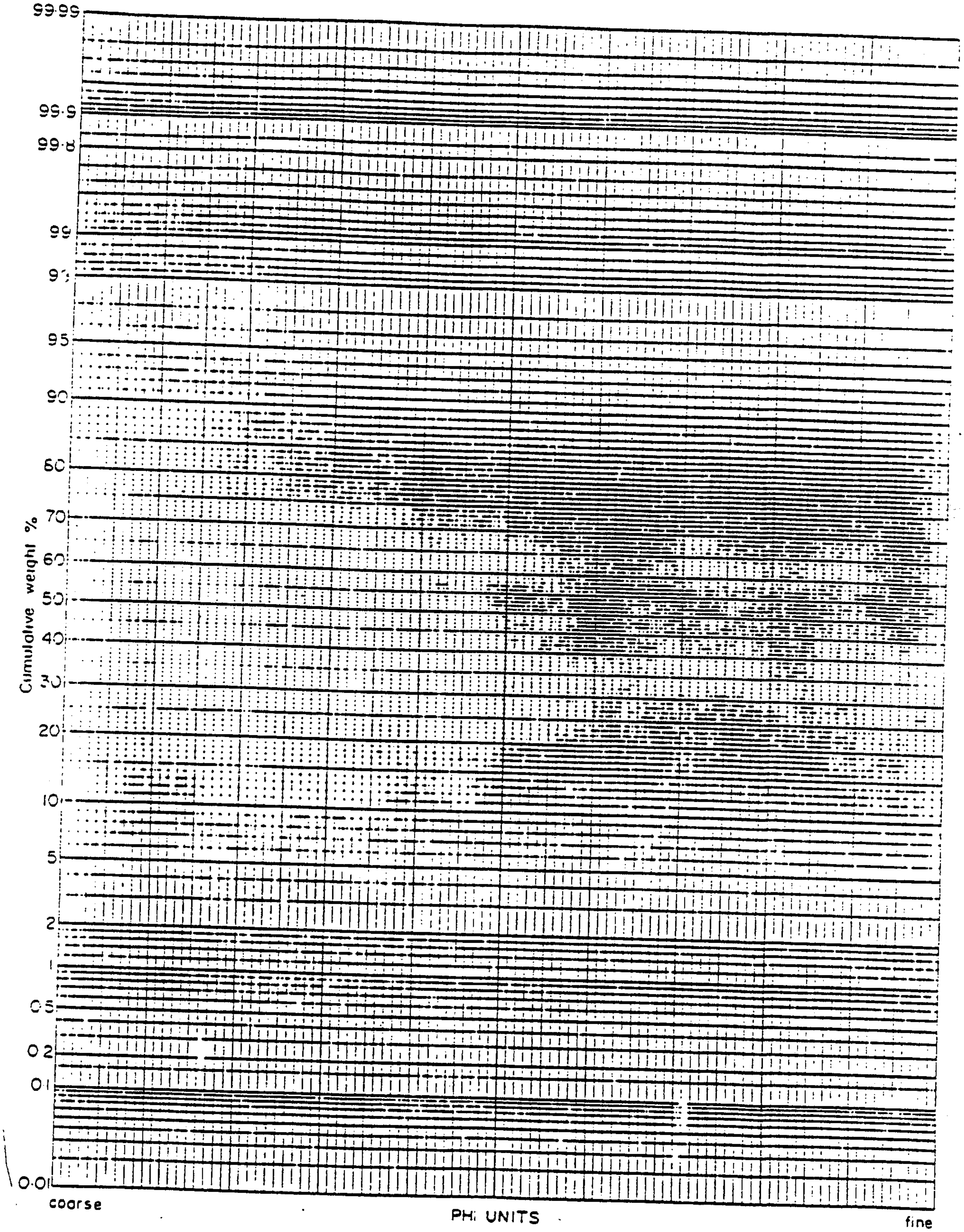
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Cumulative weight %
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FIELD PROCEDURE FP 6-7

PACKAGING AND SHIPMENT OF FIELD SAMPLES

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Subject	Procedure No.	Rev.	
	FP 6-7	0	Page 1 of 19
	Issue Date		Effective Date
PACKAGING AND SHIPMENT OF FIELD SAMPLES	05/25/90		07/02/90
	Supersedes Procedure Number	Rev.	Date
	630 FP 10		
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to define the requirements necessary for sample packaging, and information on chain-of-custody records used in sample transfer.

2.0 SCOPE

This procedure applies to the packaging, shipping, and documentation of samples being transferred from the field to the laboratory for analysis. Specifically, this document outlines shipping and sample documentation procedures that are in accord with the U.S. Department of Transportation (DOT) and HAZWRAP. This procedure is applicable to all samples taken from uncontrolled hazardous substance sites for analysis at laboratories away from the site; however, this procedure does not take precedence over region-specific or site-specific requirements for chain-of-custody.

3.0 REQUIREMENTS

Careful packaging, shipping, and documentation are necessary to insure that all samples received are undamaged and authentic.

4.0 REFERENCES

4.1 HAZWRAP, February 1989. *Quality Control Requirements for Field Methods*, DOE/HWP-69, Rev. 0.

4.2 HAZWRAP, July 1988. *Requirements for Quality Assurance of Analytical Data*, DOE/HWP-65, Rev. 0, July 1988.

4.3 U.S. Department of Transportation, 1983. *Hazardous Materials Regulations*, 49 CFR 171-177.

4.4 USEPA, 1984. *User's Guide to the Contract Laboratory Program*, Office of Emergency and Remedial Response, Washington, D.C.

5.0 DEFINITIONS

Carrier - A person or firm engaged in the transportation of passengers of property.

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-

part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to the subsequent custodian. Attachment 9.7 shows a typical Chain-of-Custody Record. Chain-of-Custody Record Form is a controlled document. One copy of the form must be retained in the project file.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under your custody if:

- You possess the sample.
- It is in your view, after being in your physical possession.
- It was in your physical possession and then you locked it up to prevent tampering.
- You have designated and identified a secure area to store the sample.

Hazardous Material - A substance or material in a quantity and form which may pose an unreasonable risk to health and safety or property when transported in commerce ("commerce" here to include any traffic or transportation). Defined and regulated by DOT (49 CFR 173.2) and listed in Attachment 9.1.

Hazardous Waste - Any substance listed in 40 CFR Subpart D (261.30 et seq) or 40 CFR otherwise characterized as ignitable, corrosive, reactive, or EP toxic as specified under Subpart C (261.20 et seq) that would be subject to manifest requirements specified in 40 CFR 262. Defined and regulated by EPA.

Marking - Applying the descriptive name, instructions, cautions, weight, or specification marks or combination thereof required to be placed outside containers of hazardous materials.

n.o.i. - Not otherwise indicated.

n.o.s. - Not otherwise specified.

ORM - Other regulated material.

Packaging - The assembly of one or more containers and any other components necessary to assure compliance with the minimum packaging requirements of 49 CFR 172, including containers (other than freight containers or overpacks), portable tanks, cargo tanks, tank cars, and multi-unit tank car tanks.

Placard - Color-coded, pictorial sign depicting the hazard class symbol and name to be placed on all four sides of a vehicle transporting certain hazardous materials.

Reportable Quantity (RQ) - A parenthetical note of the form "(RQ-1000/454)" following an entry in the DOT Hazardous Materials table (49 CFR 172.101) indicates the

reportable quantity of the substance in pounds and kilograms. If a spill of that amount or more of the substance occurs during transit or storage, a report must be filed with DOT according to 171.15-17 concerning hazardous materials incidents reports. If the material spilled is a hazardous *waste*, a report must always be filed, regardless of the amount, and must include a copy of the manifest. If the RQ notation appears, it must be shown either immediately before or after the proper shipping name on the shipping paper (or manifest). Most shipping papers and manifests will have a column designated "HM" which my be used for this purpose.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

6.0 RESPONSIBILITIES

6.1 **Field Operations Leader** - Responsible for determining that samples are properly packaged and shipped, and for determining that the chain-of-custody procedures are implemented from the time the samples are collected to their release to the shippers.

6.2 **Field Samplers** - Responsible for implementing the packaging and shipping requirements and for initiating the chain-of-custody records until they are relinquished to another custodian, to the shipper, or to the carrier.

7.0 EQUIPMENT

7.1 Coders.

7.2 Teflon and nylon strapping tape.

7.4 Vermiculite or styrofoam packaging materials.

7.5 Bubble pack.

7.6 Sampling gloves.

7.7 Poly-net.

7.8 Reclosable plastic bags.

7.9 Permanent felt tip marker.

7.10 Pen, black permanent ink.

8.0 PROCEDURE

8.1 SAMPLE PACKAGING AND SHIPPING

Samples collected for shipment from a site should be classified as either environmental or hazardous material (or waste) samples. In general, environmental samples are collected off-site (for example, from streams, ponds, or wells) and are not expected to be grossly contaminated with high levels of hazardous materials. On-site samples (for example, soil,

water, and materials from drums or bulk storage tanks, obviously contaminated ponds, lagoons, pools, and leachates from hazardous waste sites) are considered hazardous. A distinction must be made between the two types of samples in order to:

- Determine appropriate procedures for transportation of samples. If there is any doubt, a sample should be considered hazardous and shipped accordingly.

- Protect the health and safety of laboratory personnel receiving the samples. Special precautions are used at laboratories when samples other than environmental samples are received.

8.2 ENVIRONMENTAL SAMPLES

8.2.1 Packaging

Environmental samples may be packaged following the procedures outlined in Section 8.4 for samples classified as "flammable liquids" or "flammable solids". Requirements for marking, labeling, and shipping papers do not apply.

Environmental samples may also be packaged without being placed inside metal cans as required for flammable liquids or solids.

- Place sample container, properly identified and with a sealed lid, in a polyethylene bag and seal the bag.

- Place sample in a fiberboard container or metal picnic cooler which has been lined with a large polyethylene bag.

- Pack with enough nocombustible, absorbent, cushioning materials to minimize the possibility of the container breaking.

- Seal large bag.

- Seal or close outside container.

8.2.2 Marking/Labeling

Sample containers must have a completed sample identification tag and the outside container must be marked "Environmental Sample". The appropriated side of the container must be marked "This End Up" and arrows placed appropriately. No DOT markings or labeling are required.

8.2.3 Shipping Papers

No DOT shipping papers are required. However, the appropriate chain-of-custody forms must be included with the shipment.

8.2.4 Transportation

There are no DOT restrictions on mode of transportation.

8.3 Determination of Shipping Classification for Hazardous Material Samples

Samples not determined to be environmental samples, or samples known or expected to contain hazardous materials, must be considered hazardous material samples and transported according to the requirements listed below.

8.3.1 Known Substances

If the substance in the sample is known or can be identified, package, mark label, and ship according to the specific instructions for that material (if it is listed) in the DOT Hazardous Materials Table, 49 CFR 172.101.

Unz and Company have published the following steps to help in locating a proper shipping name from the Hazardous Materials Table, 48 CFR 172.101.

1. Look first for the chemical or technical name of the material, for example, ethyl alcohol. Note that many chemicals have more than one technical name; for example, perchloroethylene (not listed in 172.101) is also called tetrachloroethylene (listed in 172.101). It may be useful to consult a chemist for all possible technical names a material can have. If you material is not listed by its technical name, then....

2. Look for the chemical family name. For example, pentyl alcohol is not listed, but the chemical family name is alcohol, n.o.s. (not otherwise specified). If the chemical family name is not listed, then....

3. Look for a generic name based on end use. For example, Paint, n.o.s. or Fireworks, n.o.s. If a generic name based on end use is not listed, then....

4. Look for a generic family name based on end use. For example, Drugs, n.o.s. or Cosmetics, n.o.s. Finally if your material is not listed by a generic family name but you suspect or know the material is hazardous because is meets the definition of one or more hazard classes, then....

5. You will have to go to the general hazard class for a proper shipping name. For example, Flammable Liquid, n.o.s., or Oxidizer, n.o.s.

8.3.2 Unknown Substances

For samples of hazardous substances of Unknown content, select the appropriate transportation category according to the DOT Hazardous Materials Classification (Attachment 9.1), a priority system of transportation categories.

The correct shipping classification for an unknown sample is selected through a process of elimination, utilizing Attachment 9.1. Unless known or demonstrated otherwise (through the use of radiation survey instruments), the sample is considered radioactive and appropriate shipping regulations for "radioactive material" followed.

If radioactive material is eliminated, the sample is considered to contain "Poison A"

materials (Attachment 9.2), the next classification on the list. DOT defines "Poison A" as extremely dangerous poisonous gases or liquids of such a nature that a very small amount of gas, or vapor of the liquid, mixed with air is dangerous to life. Most Poison A materials are gases or compressed gases and would not be found in drum-type containers. Liquid Poison A would be found only in closed containers; however, all samples taken from closed drums do not have to be shipped as Poison A, which provides for a "worst case" situation. Based upon information available, a judgement must be made whether a sample from a closed container is a Poison A.

If Poison A is eliminated as a shipment category, the next two classifications are "flammable" or "nonflammable" gases. Since very few gas samples are collected, "flammable liquid" would be the next applicable category. With the elimination of radioactive material, Poison A, flammable gas, and nonflammable gas, the sample can be classified as flammable liquid (or solid) and shipped accordingly. These procedures would also suffice for shipping any other samples classified below flammable liquids in the DOT classification table (Attachment 9.1). For samples containing unknown material, categories listed below flammable liquids/solids on Attachment 9.1 are generally not used because showing that these materials are not flammable liquids (or solids) requires flashpoint testing, which may be impractical and possibly dangerous at a site. Thus, unless the sample is known to consist of material listed as less hazardous than flammable liquid (or solid) on Attachment 9.1, it is considered a flammable liquid (or solid) and shipped as such.

For any hazardous material shipment , utilize the shipping checklist (Attachment 9.3) as a guideline to ensure that all sample-handling requirements are satisfied.

8.4 Packaging and Shipping of Samples Classified as Flammable Liquid (or Solid)

8.4.1 Packaging

Applying the word "flammable" to a sample does not imply that it is in fact flammable. The word prescribes the class of packaging according to DOT regulations.

1. Collect sample in the prescribed container with nonmetallic, Teflon-lined screw cap. To prevent leakage, fill container no more than 90% full. If an air space in the sample container would affect sample integrity, place that container within a second container to meet the 90% requirement.

2. Complete sample label and identification tag and attach securely to sample container.

3. Seal container and place in a 2-ml thick (or thicker) polyethylene bag, one sample per bag. Position identification tag so that it can be read through bag. Seal bag.

4. Place sealed bag inside metal can and cushion it with enough noncombustible, absorbent material (for example vermiculite or diatomaceous earth) between the bottom and sides of the can and bag to prevent breakage and absorb leakage. Pack one bag per can. Use clips, tape, or other positive means to hold can lid securely, tightly and permanently. Mark can as indicated in Paragraph 1 of Section 8.4.2, below.

5. Place one or more metal cans (or single 1-gallon bottle) into a strong outside container, such as a metal picnic cooler or a DOT-approved fiberboard box. Surround cans with noncombustible, absorbent cushioning material for stability during transport. Mark containers as indicated in Paragraph 2 of Section 8.4.2.

8.4.2 Marking/Labeling

1. Use abbreviations only where specified. Place the following information, either-hand printed or in label form, on the metal can (or 1-gallon bottle):

   - Laboratory name and address.
   - "Flammable Liquid, n.o.s. UN1993" or "Flammable Solid, n.o.s. UN1325".
   - Not otherwise specified (n.o.s.) is not used if the flammable liquid (or solid) is identified. Then the name of the specific material is listed before the category (for example, Acetone, Flammable Liquid), followed by its appropriate UN number found in the DOT hazardous materials table (49 CFR 172.101).

2. Place all information on outside shipping container as on can (or bottle), specifically:

   - Proper shipping name.
   - UN or NA number.
   - Proper label(s).
   - Addressee and sender.

Place the following labels on the outside container: "Cargo Aircraft Only" and "Flammable Liquid" (or "Flammable Solid"). "Dangerous When Wet" label should be used if the solid has not been exposed to a wet environment. "Laboratory Samples" and "THIS SIDE UP" or "THIS END UP" should also be marked on the top of the outside container, and upward-pointing arrows should be placed on all sides of the container.

8.4.3 Shipping Papers

1. Use abbreviations only where specified. Complete the carrier-provided

bill of lading and sign certification statement (if carrier does not provide, use standard industry form, see Attachment 9.4). Provide the following information in the order listed (one form may be used for more than one exterior container).

- "Flammable Liquid, n.o.s. UN1993" or "Flammable Solid, n.o.s. UN1325).
- "Limited Quantity" (or "Ltd. Qty.").
- "Cargo Aircraft Only".
- Net weight (wt) or net volume (vol), just before or just after "Flammable Liquid n.o.s." or "Flammable Solid, n.o.s.", by item, if more than one metal can is inside an exterior container.
- "Laboratory Samples" (if applicable).

2. Include Chain-of-Custody Record, properly executed in outside container.

3. "Limited Quantity" of "Flammable Liquid, n.o.s." is limited to one pint per inner container. For "Flammable Solid, n.o.s.", net weight of inner container plus sample should not exceed one pound; total package weight should not exceed 25 pounds.

8.4.4 Transportation

1. Transport Unknown hazardous substance samples classified as flammable liquids by rented or common carried truck, railroad, or express overnight package services. Do not transport by any passenger-carrying air transport system, even if they have cargo-only aircraft. DOT regulations permit passenger airline company cargo only aircraft, but difficulties with most suggest avoiding them. Instead, ship by airline carriers that only carry cargo.

2. For transport by government-owned vehicle, including aircraft, DOT regulations do not apply. However, procedures described above, with the exception of execution of the bill of lading with certification, should still be used.

8.5 Packaging and Shipping of Samples Classified as Poison "A"

This packaging, marking, labeling, and shipping method provides a worst-case procedure for materials classed as Poison A (49 CFR 173.328). In the absence of reliable data that exclude the possibility of the presence of Poison A chemicals or compounds (see Attachment 9.2), these procedures must be followed.

8.5.1 Packaging

Applying the word "poisonous" to a sample does not imply that it is, in fact, poisonous,

or how poisonous. It describes the class of packaging according to DOT regulations.

1. Collect samples in a polyethylene or glass container with an outer diameter narrower than the valve hole on a DOT specification #3A1800 or #3AA1800 metal cylinder. To prevent leakage, fill container no more than 90% full. Seal sample container.

2. Complete sample label and identification tag and attach securely to sample container.

3. Attach string or flexible wire to neck of the sample container; lower it into metal cylinder partially filled with noncombustible, absorbent cushioning material (for example, diatomaceous earth or vermiculite). Place only one container in metal cylinder. Pack with enough absorbing material between the bottom and sides of the sample container and the metal cylinder to prevent breakage and absorb leakage. After the cushioning material is in place, drop the end of the string into the cylinder valve hole.

4. Replace valve, torque to 250 ft-lb (for 1-inch opening), and replace valve protector on metal cylinder, using Teflon tape.

5. Mark and label cylinder as described in Paragraph 1 of Section 5.5.2.

6. Place one or more cylinders in DOT-approved outside container.

7. Mark and label outside container and complete shipping papers as described below.

8.5.2 Marking/Labeling

1. Use abbreviations only where specified. Place the following information, either hand-printed or in label form, on the side of the cylinder or on a tag wired to the cylinder valve protector.

   - "Poisonous Liquid, n.o.s." or "Poisonous Gas, n.o.s. NA9035)".

   - Laboratory name and address.

   - DOT label "Poisonous Gas" (even if sample is liquid) on cylinder.

2. Put all information on metal cylinder on outside container. Print "Laboratory Sample" and "Inside Packages Comply With Prescribed Specifications" on top and/or front of outside container. Mark "THIS SIDE UP" on top of container and upward-pointing arrows on all four sides.

8.5.3 Shipping Papers

1. Use abbreviations only as specified. Complete carrier-provided bill of lading and sign certification statement (if carrier does not provide, use standard industry form, see Attachment 9.4). Provide the following

information in the order listed. One form may be used for more than one exterior container.)

- "Poisonous Liquid, n.o.s. NA9035)."
- "Limited Quantity" (or "Ltd. Qty.").
- Net weight (wt) or net volume (vol), just before of after "Poisonous Liquid, n.o.s.", of each cylinder, if more than one is inside the outer container.

2. Include a Chain-of-Custody Record, properly executed, in container or with cylinder.
3. Accompany shipping container to carrier and, if required, open outside container(s) for inspection.

8.5.4 Transportation

Transport Unknown hazardous substance samples classified as Poison A only by ground transport or Government-owned aircraft. Do not use air cargo, other common-carrier aircraft, or rented aircraft.

8.6 Transport of Investigation and Remediation Wastes

The packaging, marking, labeling, and other shipping requirements will depend on the particular waste to be transported. Examples of wastes which may be generated during the site investigations are decontamination or cleaning solutions, contaminated disposable items, test pit spoils, drilling cuttings or fluids and contaminated monitoring well discharges. Waste materials from remediation include excavation spoils, overpacked drums and discharges from drained lagoons or tanks.

In many cases, wastes generated during site investigations will be disposed of onsite. These relatively small volumes of waste will be dealt with as part of the waste to be cleaned up or isolated during remediation. This avenue should be pursued, if feasible, to avoid the inconvenience of transportation and disposal which are disproportionately expensive for small volumes. If such a solution is approved, materials should be properly bagged, drummed, covered, buried, or otherwise contained at the end of each day.

Those materials which must be transported for treatment, storage, or disposal should be packaged, labeled and marked in accordance with applicable regulations.

Many wastes generated during site investigation and remediation activities will probably be adequately handled under the classification "ORM-E" (i.e., other regulated materials, type E) Types of wastes which would normally fall under this classification are contaminated disposable protective clothing and sampling equipment, spent soapy

decontamination solutions and rinses, contaminated drilling cuttings or fluids and contaminated soils excavated during site investigations or remediation.

Spent solvents used for decontamination of sampling equipment (e.g., acetone or methanol) should be referenced by the actual product name. Liquids from drums or tanks should be specified as accurately as possible based on results of lab analysis or reliable records. If the liquid is known to be a solvent, organic liquid, or spent distillation bottoms, it should be referenced by its actual or generic name from the Hazardous Materials Table. In cases requiring emergency actions where the identity of a substance is not accurately know, place the substance in one of the general hazard classes in 49 CFR 173.2. The choice of class should be conservative; that is, use the highest priority class based on available information as described in Section 8.3.2.

The following steps for preparing hazardous materials for shipment were extracted from the "Hazardous Materials Transportation Guide for Shippers" published by the U.S. DOT. References are to CFR Title 49.

1. **Determine the Proper Shipping Name**

   The shipper must determine the proper shipping name of the materials as listed in the Hazardous Materials Table, *172.101, Column (2).

2. **Determine the Hazard Class or Classes**

   a. Refer to the Table, *172.101, Column (3) and locate the hazard class of the material or follow the steps described in Section 8.3.2 of this Guideline.

   b. If more than one class is shown for the proper shipping name, determine the proper class by definition.

   c. If the material has more than one hazard, classify the material based on the order of hazards in *173.2.

3. **Select the Proper Identification Number**

   a. Refer to the Table, 172.101, Column (3a) and select the Identification Number (ID) that corresponds to the proper shipping name and hazard class.

   b. Enter the ID Number(s) on the shipping papers and display them, as required, on packaging, placards, and/or orange panels.

4. **Determine the Mode(s) of Transport to Ultimate Destination***

   a. As a shipper, you must assure yourself that the shipment complies with the various modal requirements.

b. The modal requirements may affect the following:

(1) Packaging

(2) Quantity per package

(3) Marking

(4) Labeling

(5) Shipping papers

(6) Certification

* For example, truck, rail or air.

5. Select the Proper Label(s) and apply as required

Required labels are based on the hazard class of the substance to be shipped. No placards are required on vehicles transporting ORM-E substances or limited quantities of any hazardous materials (e.g., hazardous samples as discussed in Section 8.4).

a. Refer to the Table, 172.101, Column (4) for required label(s).

b. For details in labeling refer to:

(1) Additional Labels, 172.402

(2) Location of Labels, 172.406

(3) Packaging (Mixed or Consolidated), 172.404(a) and (b)

(4) Packages Containing Samples, 172.402(h)

(5) Radioactive Materials, 172.403

(6) Authorized Label Modification, 172.405

6. Determine and Select the Proper Packaging

a. Refer to the Table, 172.101, Column (5a) for exceptions and Column (5b) for authorized Packaging. Consider the following when selecting an authorized container: Quantity per package; Cushioning material, if required; Proper closure and reinforcement; Proper pressure; Outage; etc, as required.

b. If packaged by a prior shipper, make sure the packaging is correct and in proper condition for transportation.

7. **Mark the Packaging (Including Overpacks)**

   a. Apply the required marking (172.300); Proper shipping name and ID number, when required (172.301); Name and address of Consignee and Consignor (172.306).

   b. For details and other required markings, see *172.300 through *172.338.

8. **Prepare Shipping Papers**

   a. The basic requirements for preparing shipping papers include: proper shipping name; hazard class; ID number; total quantity; shipper's certification.

   b. Make all entries on the shipping papers, using the information required, and in proper sequence (172.202).

   c. For additional requirements, see 172.200 through 172.205.

9. **Certification**

   a. Each shipper must certify, by printing (manually or mechanically) on the shipping papers, that the materials being offered for shipment are properly classified, described, packaged, marked, and labeled, and are in proper conditions for transportation according to the applicable DOT Regulations (172.204).

10 **Loading, Blocking, and Bracing**

When loading hazardous materials into the transport vehicle or freight container, each package must be loaded, blocked, and braced in accordance with the requirements for the mode of transport.

   a. If the shipper loads the freight container or transport vehicle, the shipper is responsible for the proper loading, blocking, and bracing of the materials. The packages must be properly labeled as to the right side up and samples must be packed to avoid damage in case of overturning.

   b. If carrier personnel do the loading, the carrier is responsible.

11. **Determine the Proper Placard(s)**

Each person who offers hazardous materials for transportation must determine that the placarding requirements have been met.

   a. For highway, unless the vehicle is already correctly placarded, the shipper must provide the required placard(s) and required identification number(s) (172.506).

b. For rail, if loaded by the shipper, the shipper must placard the rail car if placards are required. (172.508)

c. For air and water shipments, the shipper has the responsibility to apply the proper placards.

12. **Hazardous Waste/Hazardous Substance**

a. If the material is classed as a hazardous waste or hazardous substance, most of the above steps will be applicable.

b. Pertinent Environmental Protection Agency Regulations are found in the Code of Federal Regulations, Title 40, Part 262.

8.6 Chain-of-Custody Guidelines

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is what it is represented to be. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom. These procedures also provide an auditable trail for the evidence as it is moved and/or passes from the custody of one individual to another. In addition, procedures for consistent and detailed records facilitate the admission of evidence under Rule 803(b) of the Federal Rules of Evidence (P.L. 93-575).

Chain-of-custody procedures, record keeping, and documentation are an important part of the management control of samples in the HAZWRAP program. Regulatory agencies must be able to provide the chain of possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

8.6.1 Sample Identification

The following information shall be written in the sample log book when in-situ measurements or samples for laboratory analysis are collected:

- project code;
- station number;
- location of station;
- date and time of measurement;
- samples used (if any);
- field observations (include date and time);
- level of personnel protection (if required);

- equipment used to make physical measurements and collect samples; and
- calibration data for equipment used.

Measurements and observations shall be recorded using black, waterproof ink.

8..6.2 Sample Label

Samples, other than in-situ measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling Plan. Each sample container is identified by a sample label (see Attachment 9.5).

Sample labels are provided by the HAZWRAP Program Office. The sampler fills out the following information on the sample label:

Project	HAZWRAP Work Assignment Number
Sample Number	The unique sample number identifying this sample
Date	A six-digit number indicating the month, day, and year of sample collection; e.g., 12/21/85
Time	A four digit number indication the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.)
Medium	Water, Soil, Sediment, Sludge, Leachate, etc.
Sample Type	Grab or Composite
Preservation	Type, quantity, and concentration of preservative added
Analysis	Same as Analyses on Sample Identification Tag (see Section 8.6.3)
Sampled by	Name of the sampler
Lab #	The receiving laboratory assigns the lab# to the sample label (this number is not to be used for on-site analyses)
Remarks	If for Contract Lab analysis, include the Contract Lab case of SAS number, and Contract Lab sample number from the traffic report, SAS Packing List, or Dioxin Shipment Record. Also, pertinent observations of the sampler (e.g., sequence number for sequential samples).

8.6.3 Sample Identification Tag

A Sample Identification Tag (Attachment 9.6) must also be used for samples collected for Control Lab analysis. The Sample Identification Tag is a white, waterproof paper label, approximately 3-by-6 inches, with a reinforced eyelet, and string or wire for attachment to the neck of the sample bottle. The sample tag is a controlled document, and is provided by the regional EPA office. The field sampler completes the sample tag and attaches the sample tag to the field sample container. Following sample analysis, the sample tag is retained by the laboratory as evidence of sample receipt and analysis.

The following information is recorded on the tag:

Site Name/Project Code	HAZWRAP Work Assignment Number
Field Identification or Station Number	Same as Sample Number on Sample Label
Month/Day/Year	Same as Date on Sample Label
Time	Same as Time on Sample Label
Designate: Comp/Grab	Designate the sample as either grab or composite
Station Location	Site-specific station location designation defined in Site Operation Plan
Type of Sample	Type of Sample (matrix), and a brief description of the sampling location
Samplers	Same as Sampled By on Sample Label
Signature	The Sampler signs the sample tag
Preservative	Yes or No
Analyses	Check appropriate box(es)
Remarks	Same as Remarks on Sample Label (make sure Contract Lab Case No/SAS no. and Contract Lab sample numbers are recorded)
Lab Sample No.	Same as Lab# on Sample Label

The tag is then tied round the neck of the sample bottle.

If the sample is to be split, it is equally divided into two similar sample containers.

Identical information is completed on the label attached to each split and both of these are marked "Split" on the "Remarks" line.

Blank, duplicate, or field spike samples shall *not* be identified as such on the label, as this may compromise the quality control function.

8.6.4 Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed.

Field Custody Procedures

1. Samples are collected as described in the project-specific Work Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label exactly matches those numbers on the sample log sheet and the Chain-of-Custody Record.

2. The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

3. When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once developed, the photographic prints shall be serially numbered, corresponding to the logbook descriptions.

4. Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions, e.g., a logbook notation would explain that a pencil was used to fill out the sample label because a ballpoint pen would not function in freezing weather.

8.6.5 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form (Attachment 9.7). The appropriate form should be obtained from the Office in which the work takes place. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of Custody Record is filled out as follows:

1. Enter header information (project number and name, Contract Lab case No. or SAS No.). For each station number, enter date, time, composite/grab, station location, number of containers, analytical parameters, Traffic Report/SAS Packing List/Dioxin Shipment Record, and Sample Identification Tag Number

2. Sign, date, and enter the time under "Relinquished by" entry.

3. Make sure that the person receiving the sample signs for the "Received by" entry, or enter the name of the carrier (e.g., UPS, Federal Express) under "Received by". Receiving laboratory will sign "Received for Laboratory by" on the lower line and enter the date and time.

4. Enter the bill-of-lading or Federal Express airbill number under "Remarks or Reason for Change of Custody", if appropriate.

5. Place the original (top, signed copy) of the Chain-of-Custody Recorded Form in the appropriate sample shipping package. Retain a copy with field records.

6. Shipping containers should be secured to ensure samples have not been disturbed during transport by using nylon strapping tape and EPA custody seals. The custody seals should be placed on the containers so that they cannot be opened without breaking the seal.

7. Complete other carrier-required shipping papers.

The custody record is completed using black waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct informations. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the sample container (enclosed with the other documentation is a plastic zip-lock bag). As long as custody forms are sealed inside the sample container and the custody seals are intact, commercial carriers are not required to sign off on the custody form.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal log books and custody records throughout sample preparation and analysis.

8.6.6 Receipt for Samples Form

Whenever samples are split with a private party or government agency, a separate Receipt for Samples Record Form (see Attachment 9.9) is prepared for those samples and marked to indicate with whom the samples are being split. The person relinquishing the samples to the party of agency shall require the signature of a representative of the appropriate party acknowledging receipt of the samples. If a representative is unavailable or refuses to sign, this is noted in the "Received by " space. When appropriate, as in the case were the representative is unavailable, the custody record should contain a statement that the samples were delivered to the designated location at the designated time. This form must be

completed and a copy given to the owner, operator, or agent-in-charge even if the offer for split samples is declined. The original is retained by the Field Operations Leader.

9.0 ATTACHMENTS

9.1 DOT Hazardous Materials Classification (49 CFR 173.2).

9.2 DOT List of Class "A" Poison (49 CFR 172.101).

9.3 Hazardous Material Shipping Checklist.

9.4 Standard Industry Certification Form.

9.5 Sample Label.

9.6 Sample Identification Tag.

9.7 Chain-of-Custody Record Form.

9.8 Chain-of-Custody Seal.

9.9 Receipt For Samples Form.

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DOT HAZARDOUS MATERIAL CLASSIFICATION (49 CFR 173.2)

1. Radioactive material (except a limited quantity)
2. Poison A
3. Flammable gas
4. Nonflammable gas
5. Flammable liquid
6. Oxidizer
7. Flammable solid
8. Corrosive material (liquid)
9. Poison B
10. Corrosive material (solid)
11. Irritating material
12. Combustible liquid (in containers have capacities of 110 gallons [415 liters])
13. ORM-B
14. ORM-A
15. Combustible liquid (in containers having capacities of 110 gallons [416 liters] or less)
16. ORM-E

DOT LIST OF CLASS "A" POISON (49 CFR 172.101)

MATERIAL TEMPERATURE	PHYSICAL STATE AT STANDARD TEMPERATURE
Arsine	Gas
Bromoacetone	Liquid
Chloropicrin and methyl chloride mixture	Gas
Chloropicrin and nonflammable, nonliquified compressed gas mixture	Gas
Cyanogen chloride	Gas(>13.1°C)
Cyanogen gas	Gas
Gelatin dynamite (H. E. Germaine)	---
Grenade (with Poison "A" gas charge)	---
Hexaethyl tetraphosphate/compressed gas mixture	Gas
Hydrocynic (prussic) acid solution	Liquid
Hydrocyanic acid, liquefiedLiquid	
Insecticide (liquefied) gas containing Poison "A" or Poison "B" material	Gas
Methyldichloroarsine	Liquid
Nitric oxide	Gas
Nitrogen peroxide	Gas
Nitrogen tetroxide	Gas
Nitrogen dioxide, liquid	Gas
Parathion/compressed gas mixture	Gas
Phosgene (diphosgene)	Liquid

HAZARDOUS MATERIALS SHIPPING CHECKLIST

Packaging

1. Check DOT 172.500 table for appropriate type of package for hazardous substance.
2. Check for container integrity, especially the closure.
3. Check for sufficient absorbent material in package.
4. Check for sample tags and log sheets for each sample, and chain-of-custody record.

Shipping Papers

1. Check that entries contain only approved DOT abbreviations.
2. Check that entries are in English.
3. Check that hazardous material entries are specially marked to differentiate them from any nonhazardous materials being set using same shipping paper.
4. Be careful that all hazardous classes are shown for multiclass materials.
5. Check total amounts by weight, quantity, or other measures used.
6. Check that any limited-quantity exemptions are so designated on the shipping paper.
7. Offer driver proper placards for transporting vehicle.
8. Check that certification is signed by shipper.
9. Make certain that driver signs for shipment.

RCRA Manifest

1. Check that approved state/federal manifests are prepared.
2. Check that transporter has the following: valid EPA identification number, valid driver's license, valid vehicle registration, insurance protection, and proper DOT labels for materials being shipped.
3. Check that destination address is correct.
4. Check that driver knows where shipment is going.
5. Check that the driver is aware of emergency procedures for spills and accidents.
6. Make certain driver signs for shipment.
7. Make certain one copy of executed manifest and shipping document is retained by shipper.

STANDARD INDUSTRY CERTIFICATION/FORM

NO PCS	SIZE	GROSS WEIGHT	H M	D.O.T. PROPER SHIPPING NAME	HAZARD CLASS	CODE	I D	CONTAINER NUMBERS	PIC	BULK
1	55 gal	200 lbs.	x	Nitric Acid, Fuming	Oxidizer	55-BN	C	1	✓	
1	55 gal	450 lbs	x	Flammable Liquid, n.o.s.	Flammable Liquid	55-AM	—	2		✓
1	55 gal	250 lbs	x	Flammable Liquid, n.o.s.	Flammable Liquid	55-BN	D	3	✓	
1	15-A	12 lbs.	x	Bromine	Corrosive Material	55-BN	C	4	✓	

SHIPPER'S CERTIFICATION

This is to certify that the above named materials are properly classified, described, packaged, marked and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.

Shipper's Signature

Placards Req'd

Shipment Date Manifest No

Disposal Work Order

Service Order No

SAMPLE LABEL

PROJECT: ____________________

SAMPLE NO. ____________________

DATE: __/__/__ TIME: ____________ HRS

MEDIUM: ____________________

TYPE: *GRAB* ☐ *COMPOSITE* ☐

PRESERVATION: ____________________

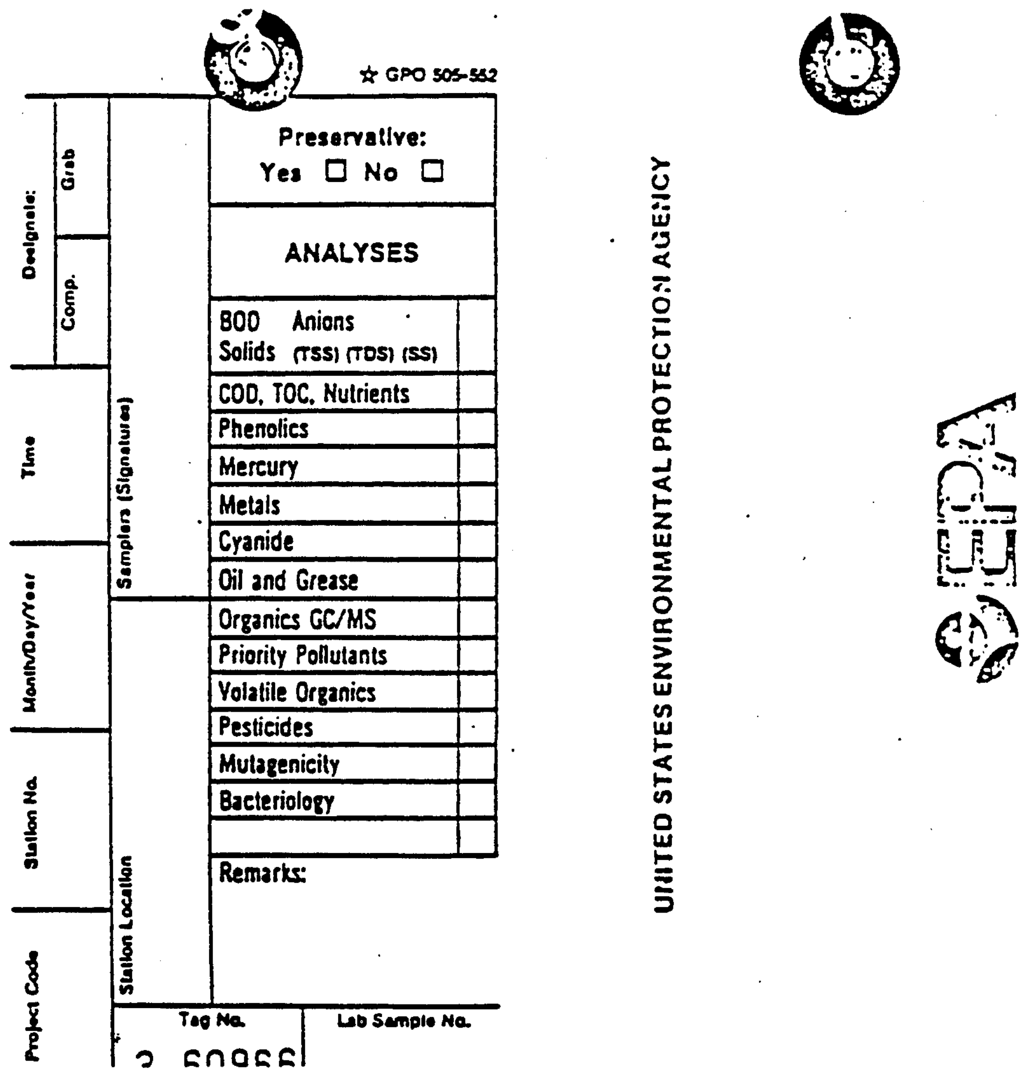
ANALYSIS: ____________________

SAMPLED BY: ____________________

LAB NO.: ____________________

REMARKS: ____________________

SAMPLE IDENTIFICATION TAG



ATTACHMENT 9.7
FP 6-7

CHAIN-OF-CUSTODY FORM

CHAIN-OF-CUSTODY RECORD

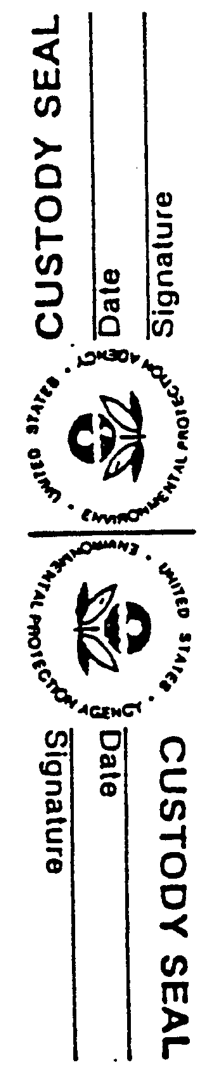
ES JOB NO.	PROJECT NAME/LOCATION			
SAMPLER(S): (Signature)				
DATE	TIME	SAMPLE DESCRIPTION	NO. OF CON- TAINERS	WATER ANALYSES REQUIRED	SHIP TO: REMARKS

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	

Distribution: Original Accompanies Shipment, Copy to Coordinator Field Files

ATTACHMENT 9.8
FP 6-7

CHAIN-OF-CUSTODY SEAL



ATTACHMENT 9.9
FP 6-7

RECEIPT FOR SAMPLES FORM

RECEIPT FOR SAMPLES
EPA WORK ASSIGNMENT NUMBER ______

E S WORK CHARGE NO. 4238.	PROJECT NAME	Name of Facility
SAMPLERS: (Signature)		Facility Location
Split Samples Offered [ ] Accepted [ ] Declined		

STA. NO.	DATE	TIME	COMP.	GRAB	SPLIT SAMPLES	TAG NUMBERS	STATION DESCRIPTION	NO. OF CON-TAINERS	REMARKS

Transferred by: (Signature)		Received by: (Signature)		Telephone
Date	Time	Title	Date	Time

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FIELD PROCEDURE FP 7-1

AQUIFER SLUG TESTING

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Subject	Procedure No. / Rev.	
AQUIFER SLUG TESTING	Procedure No.: FP 7-1	Rev.: 0 — Page 1 of 6
	Issue Date: 05/25/90	Effective Date: 07/02/90
	Supersedes Procedure Number: 630 FP 1	Rev.: 0 — Date:
Acceptance - Program QA	Approval - Program Manager	

1.0 PURPOSE

The purpose of this procedure is to define the requirements for performing the slug test, which is a single well hydraulic test to determine the transmissivity and hydraulic conductivity of an aquifer.

2.0 SCOPE

The slug test method is recommended for confined aquifers with transmissivity less than 7000 ft^2/day. This method can be used to determine estimates of transmissivity for an aquifer in the immediate vicinity of the tested well. The value of transmissivity determined from slug testing will apply only over the screened interval. The test can be performed using either a rising head or a falling head method.

3.0 REQUIREMENTS

Prior to testing, the well should be thoroughly developed and water levels allowed to stabilize. Tests performed after extended periods of pumping or water addition may yield inaccurate results. Decontaminate slugs prior to and immediately after the performance of the slug test according to appropriate decontamination procedures.

4.0 REFERENCES

4.1 American Society for Testing and Materials, 1987. ASTM Method D4630-86 and D4631-86, Annual Book of Standards, ASTM, Philadelphia, PA.

4.2 Bouwer, H. and R.C. Rice, 1976. *A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers With Completely or Partially Penetrating Wells*, Water Resources Research, Vol. 12, No. 3.

4.3 Cedergren, H.R., 1977. *Seepage, Drainage, and Flow Nets* (2nd Edition), John Wiley and Sons, Inc., New York.

4.4 Cooper, Hilton H., Jr., John D. Bredehoeft, and Stavros S. Papadopulos, 1967. *Response of a Finite-Diameter Well to an Instantaneous Charge of Water*, Water Resources Research, Vol. 3, No. 1.

4.5 Freeze, R.A. and J.A. Cherry, 1979. *Groundwater*. Prentice Hall, Englewood Cliffs, NJ.

4.6 In-Situ, Inc, 1985. *Hermit Environmental Data Logger Model SE1000B Owner's Manual*. Laramie Wyoming.

4.7 Lohman, S.W., 1972, *Ground-Water Hydraulics*, U.S. Geological Survey, Professional Paper 708.

4.8 Papadopulos, Stavros S., John D. Bredehoeft, Hilton H. Cooper, Jr., 1967. *On the Analysis of 'Slug Test' Data*, Water Resources Research, Vol. 9, No. 4.

4.9 U.S. Department of Interior, Bureau of Reclamation, 1974. "Designation E-18, Field Permeability Tests in Boreholes" in *Earth Manual*, 2nd Edition, U.S. Government Printing Office, No. 2403-00079.

4.10 U.S. Department of Interior, 1981. *Groundwater Manual*.

5.0 DEFINITIONS

Hydraulic Conductivity (K) - A quantitative measure of the ability of porous material to transmit water. Volume of water that will flow through a unit cross-sectional area of porous material per unit time under a hydrostatic gradient. Hydraulic conductivity is dependent upon properties of the medium and fluid. Also referred to as "permeability".

Transmissivity (T) - A quantitative measure of the ability of an aquifer to transmit water. It is the product of the (hydraulic conductivity) X (saturated thickness).

Slug-test - A rising head or falling head test. A slug test consists of adding a slug (of water, or a solid cylinder) of known volume to the well to be tested or removing a known volume of water and measuring the rate of recovery of water level inside the well. The slug of known volume acts to raise or lower the water level in the well.

Rising-head test - A test used in an individual well within the saturated zone to estimate the hydraulic conductivity of the surrounding formation by lowering the water level in the well and measuring the rate of recovery of the water level. The water level may be lowered by pumping or bailing. Also know as a bail test.

Falling head test- A test used in an individual well to estimate the hydraulic conductivity of the surrounding formation by raising the water level in the well by insertion of a slug or quantity of water, and then measuring the rate of drop in the water level.

6.0 RESPONSIBILITIES

6.1 Field Operations Leader

The Field Operations Leader will be responsible for ensuring that complete documentation is available for boreholes to be tested and for overall implementation of this procedure.

6.2 Project Hydrogeologist

The Project Hydrogeologist will be responsible for planning and overseeing the in-situ hydraulic conductivity (slug) tests. The wells to be tested and the testing methods to be used should be determined by the Project Hydrogeologist. He should also supervise the testing program to ensure that valid results are obtained.

7.0 EQUIPMENT

1. Slugs or bailer tube.
2. One-quarter inch nylon rope.
3. Water level indicator.
4. Pressure transducer-sensor.
5. Automatic data recording instrument such as the Hermit Environmental Data Logger, In Site, Inc., Model SE 1000B.
6. Field Logbook.
7. Aquifer Test Data Form (Attachment 9.1).

8.0 PROCEDURE

Aquifer transmissivity tests (slug tests) are accomplished by either removal of a quantity of water (rising head) or introduction of a metal slug or quantity of water (falling head), and then allowing the water level to stabilize. Water level measurements are taken at closely spaced intervals.

8.1 Rising-Head Test

8.1.1 All equipment will be decontaminated according to appropriate decontamination procedures.

8.1.2 The well should be opened. When wells are located *within* the 100 year flood plain, and equipped with water tight caps, the well should be opened at least 24 hours prior to testing to allow the water level to stabilize.

8.1.3 The Aquifer Test Data form (Attachment 9.1) should be prepared with entries for:

- Borehole/Well number.
- Project number.
- Project name.
- Aquifer testing team.
- Distance from pumping wells (if appropriate).

- Ground surface elevation.
- Top of well casing elevation.
- Measuring equipment being used.
- Page number.
- Static water level.
- Date.
- Time intervals (0,1,3,5,7,9,10, and 12 minutes and every three minutes thereafter through 60 elapsed minutes, then in 10 minute intervals for the next hour, and in 30 minute intervals for the next 3 hours).

8.1.4 The electric well sounder must be prepared by placing a piece of tape lengthwise along the sounder wire. The tape should extend a measured distance above and/or below the top of the surface casing. Those lengths will depend on whether a falling or rising head test is used, and how much drawdown or displacement of water level is anticipated. A second piece of tape should be placed adhesive side down, over the opposite side of the sounder wire and onto the adhesive surface of the first piece of tape.

8.1.5 The sounder must be lowered into the well to the top of the static water level.

8.1.6 A rising head slug test will be conducted by "instantly" (as rapidly as possible) withdrawing a quantity of water. This will be accomplished be using a bailer or pump to remove a "slug" of water. Alternatively, a volume of water should be "removed" from the well with a displacement tube by lowering in a water displacement tube, allowing static water levels to be re-established, and the "instantly" withdrawing the tube.

8.1.7 Immediately after the slug test is initiated by withdrawing a quantity of water or by using the water displacement tube, water levels must be marked directly on the tape on the sounder wire at the pro-established time intervals. The top of the surface casing will be used as the reference point. One person will call out the times for measurements and another person will measure water levels and mark the tape. Measuring and marking of the tape should continue until the well water returns to its initial level.

8.1.8 The sounder wire should be removed from the well, the head elevations measured with a measuring tape, and measurements recorded at the appropriate time increments on the Aquifer Test Data Form, Attachment 9.1.

8.1.9 The values should be plotted on semilog paper as follows:

- Logarithmic scale: time

- Arithmetic scale: ratio of H/H_0 - [depth to measured head/depth to initial (static) head]

8.2 Falling-Head Test

8.2.1 All equipment will be decontaminated according to appropriate decontamination procedures.

8.2.2 The well should be opened. When wells are located within the 100 year flood plain, and equipped with water tight caps, the well should be opened at least 24 hours prior to testing to allow the water level to stabilize.

8.2.3 The Aquifer Test Data form Attachment 1 should be prepared with entries for:

- Borehole/Well number.
- Project number.
- Project name.
- Aquifer testing team.
- Distance from pumping wells (if appropriate).
- Ground surface elevation.
- Top of well casing elevation.
- Measuring equipment being used.
- Page number.
- Static water level.
- Date.
- Time intervals (0, 1, 3, 5, 7, 9, 10, and 12 minutes and every three minutes thereafter through 60 elapsed minutes, then in 10 minute intervals for the next hour, and in 30 minute intervals for the next 3 hours).

8.2.4 The electric well sounder must be prepared by placing a piece of tape lengthwise along the sounder wire. The tape should extend a measured distance above and/or below the top of the surface casing. Those lengths will depend on whether a falling or rising head test is used, and how much drawdown or displacement of water level is anticipated. A second piece of tape should be placed adhesive side down over the opposite side of the sounder wire and onto the adhesive surface of the first piece of tape.

8.2.5 The sounder must be lowered into the well to the top of the static water level.

8.2.6 An appropriate transducer should be placed into the well and the displaced water allowed to return to its static level. A bailer or water displacement tube that has a diameter which allows removal from the well without displacing the transducer should be selected.

8.2.7 Recording of data by the logger should be initiated and a quantity of water withdrawn or displaced as described above in Method I.

NOTE: Proper operation of the In-Situ, Inc., Hermit Data Logger will require use of the Owner's Manual.

8.2.8 When the water level has returned to its static level, data recording should be stopped, the transducer removed from the well, and the data downloaded from the logger onto a computer for analysis (In-Situ, Inc., 1985).

9.0 ATTACHMENTS

9.1 Aquifer Test Data Form

ATTACHMENT 9.1
FP 7-1

AQUIFER TEST DATA FORM

Project	Test No.
Type of Test	Geologist
Procedure	Ground Elevation
Procedure Location	Depth of Test Run
Identification of Equipment Used	Water Level Reference Elevation
Well information:	
Depth of uncased borehole	Screen slot size
Casing Diameter	Borehole/sand pack size
Well pipe and screen diameter and length	

Time Data	Water Level Data	Discharge Data	Comments on factors affecting test data
Pump on Pump off Duration of aquifer test Pumping Recovery	Static Water Level	Depth of pump/air line Previous pumping (Y/N)	

Date	Clock Time	Start Time	End Time	t/t1	Water Level (BTC)	Correction or Conversion	Adj. Water Level	Water Level Change (s/s1)	Discharge Measurement Units:	Rate Units:		

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FIELD PROCEDURE FP 7-2

WATER LEVEL MEASUREMENT

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Subject	Procedure No. / Rev.	
	FP 7-2 / 0	Page 1 of 5
WATER LEVEL MEASUREMENT	Issue Date: 05/25/90	Effective Date: 07/02/90
	Supersedes Procedure Number: 630 FP 4, Rev. 0, Date:	
Acceptance - Program QA	Approval - Program Manager	

1.0 PURPOSE

The purpose of this procedure is to provide general reference information and technical guidance on the measurement of piezometric head levels and the determination of the direction of ground-water flow, using contour maps of the water table or potentiometric surface of a confined aquifer.

2.0 SCOPE

This procedure gives overall technical guidance for obtaining piezometric head measurements in wells (frequently conducted in conjunction with ground-water sampling) and preparation of ground-water contour maps. The specific methods utilized could be modified by requirements of project-specific work plans.

3.0 REQUIREMENTS

Ground-water level measurements can be made in monitoring wells, private or public water wells, piezometers, open boreholes, or test pits (after stabilization). Ground-water measurements should generally not be made in boreholes with drilling rods or auger flights present. If ground-water sampling activities are to occur, ground-water level measurements shall take place prior to well evacuation or sampling.

4.0 REFERENCES

4.1 HAZWRAP, February 1989. *Quality Control Requirements for Field Methods*, DOE/HWP-69.

4.2 Freeze, R.A. and J.A. Cherry, 1979. Groundwater, Prentice-Hall, Englewood Cliffs, NJ. 604 pp.

5.0 DEFINITIONS

Artesian Conditions - A common condition in a confined aquifer in which the water level in a well completed within the aquifer rises above the top of the aquifer.

Confined Aquifer - An aquifer confined between two low permeability layers (aquitards).

Equipotential Line - A contour line on the potentiometric surface or water table showing uniform piezometric head levels. Equipotential lines on the water table are also called water-table contour lines.

Flow Line - A line indicating the direction of ground-water movement within the saturated zone. Flow lines are drawn perpendicular to equipotential lines.

Flow Net - A diagram of ground-water flow, showing flow lines and equipotential lines.

Piezometric Head - The height to which water will rise in a cased well.

Potentiometric Surface - A surface which is defined by the levels to which water will rise in cased wells which are screened in a specified zone of an unconfined aquifer or in a confined aquifer.

Unconfined (water table) aquifer - An aquifer in which the water table forms the upper boundary.

Water Table - A surface in an aquifer where ground-water pressure is equal to atmospheric pressure (i.e., the pressure head is zero) and below which all strata are saturated with water.

6.0 RESPONSIBILITIES

6.1 **Field Operations Leader/Project Hydrogeologist** - has overall responsibility for obtaining water level measurements and developing ground-water contour maps. The hydrogeologist shall specify the reference point from which water levels are measured (usually a specific point on the upper edge of the inner well casing), the number of data points needed and which wells shall be used for a contour map, and how many complete sets of water levels are required to adequately define ground-water flow directions (e.g., if there are seasonal variations).

6.2 **Field Personnel** - must have a basic familiarity with the equipment and procedures involved in obtaining water levels, and must be aware of any project-specific requirements.

7.0 EQUIPMENT

The equipment used to make water level measurements consists of the following:

7.1. Steel retractable engineer's measuring tape calibrated to 0.01 foot.

7.2. Electronic water level indicator with the probe tape calibrated at minimum of 1.0 foot increments.

7.3 Portable HNu photoionization detector.

7.4 Methanol and deionized water for decontamination of the water level indicator.

7.5 Ground-water Sampling Form.

8.0 PROCEDURE

8.1 General

- Initial monitoring of the well headspace and breathing zone concentrations using a PID (HNU) or FID (OVA) and combustible gas meters shall be evaluated by the health and safety officer to determine required levels of protection.

- All ground-water level measurements shall be made to the nearest 0.01 foot, and recorded in a logbook or Ground-water Sampling Form (Attachment 9.1). In measuring ground-water levels, there shall be a clearly-established reference point of known altitude, which is normally identified by a painted mark at one point on the upper edge of the inner well casing. The field notes recorded must clearly describe the reference used. To be useful, the reference point should be tied in with an established USGS benchmark or other properly surveyed altitude datum. Typically, altitude reference data are tied to mean sea level, as determined by the 1929 General Adjustment. An arbitrary datum could be used for an isolated group of wells if necessary.

- After a monitoring or ground-water observation well has been installed and the ground-water level has stabilized, the initial depth to the water shall be measured and recorded. The date and time of the reading must be recorded. Information related to precipitation should be included in the data. The total depth of the well shall be measured and recorded.

- Cascading water within a borehole can cause false readings with some types of sounding devices (chalked line, electrical). Oil layers may also cause problems in determining the true water level in a well.

- Water level readings shall be taken regularly, as required by the site hydrogeologist. All water level measurements at a site used to develop a ground-water contour map must be made in the shortest time practical, and at least during the same day.

8.2 Water Level Measuring Techniques

There are several methods for determining standing or changing water levels in boreholes and monitoring wells. Certain methods have particular advantages and disadvantages depending upon well conditions. A general description of these methods is presented, along with a listing of various advantages and disadvantages of each technique. An effective technique shall be selected for the particular site conditions by the onsite hydrogeologist.

Water levels can be measured by several different techniques, but the same steps shall be followed in each case. The proper sequence is as follows:

1. Check operation of recording equipment above ground. Prior to opening the well, don personal protective equipment as required. Wells that have

been completed with a water-tight cap should be opened at least 24 hours prior to measurement to allow the water level to stabilize.

2. All ground-water level measurement devices must be decontaminated before and after each use to prevent cross contamination of wells.

3. Record all information specified below on a Ground-water Sampling Form (Attachment 9.1) or in field notebook if the form is not available.

4. Record well number, top of casing altitude and surface altitude if available. Well diameter and total depth should be recorded. Water levels shall be taken from the surveyed reference mark on the top edge of the inner well casing.

5. Record water level to the nearest 0.01 foot (0.3 cm).

6. Record the time and day of the measurement.

7. Many water level measuring devices have marked metal or plastic bands clamped at intervals along the measuring line used for reference points to obtain depth measurements. The spacing and accuracy of these bands shall be checked frequently as they may loosen and slide up or down the line, resulting in inaccurate reference points.

8.3 Water Level Measuring Devices

Electric Water Level Indicators

These devices consist of a spool of small-diameter cable and a weighted probe attached to the end. When the probe comes in contact with the water, an electrical circuit is closed and a meter, light, and/or buzzer attached to the spool will signal the contract.

There are a number of commercial electric sounders available, none of which is entirely reliable under all conditions likely to occur in a contaminated monitoring well. In conditions where there is oil on the water, ground-water with high specific conductance, water cascading into the well, or a turbulent water surface in the well, measuring with an electric sounder may be difficult.

For accurate readings, the probe shall be lowered slowly into the well. The electric tape is marked at the measuring point where contact with the water surface was indicated. The distance from the mark to the nearest tape band is measured using an engineer's folding ruler or steel tape and added or subtracted to the nearest band reading to obtain the depth to water. Band spacing shall be checked periodically.

Chalked Steel Tape

Water level is measured by chalking a weighted steel tape and lowering it a known distance (to any convenient whole foot mark) into the well or borehole. Water level is

determined by subtracting the wetted chalked mark from the total length lowered into the hole. The tape shall be withdrawn quickly from the well because water has a tendency to rise up the chalk due to capillary action.

Disadvantages to this method include the following: Depths are limited by the inconvenience of using heavier weights to properly tension longer tape lengths (typically, 100 foot tapes require a 10 to 12 pound weight to tension adequately); ineffective if borehole/well wall is wet or inflow is occurring above the static water level; chalking the tape is time consuming; difficult to use during periods of precipitation.

Popper or Bell Sound

A bell or cup shaped weight that is hollow on the bottom is attached to a measuring tape and lowered into the well. A "plopping" or "popping" sound is made when the weight strikes the surface of the water. An accurate reading can be determined by lifting and lowering the weight in short strokes, and reading the tape when the weight streaks the water. This method is not sufficiently accurate to obtain water levels to 0.01 feet, and thus is more appropriate for obtaining only approximate water levels quickly.

Float Recorder

A float or an electromechanically actuated water-seeking probe may be used to detect vertical changes of the water surface in the hole. A paper-covered recording chart drum is rotated by the up and down motion of the float via a pulley and reduction gear mechanism, while a clock drive moves a recording pen horizontally across the chart. To ensure continuous records, the recorder shall be inspected, maintained, and adjusted periodically.

9.0 ATTACHMENTS

9.1 Ground-water Sampling Form.

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ATTACHMENT 9.1
FP 7-2
2 Pages

GROUND-WATER SAMPLING FORM

3. GROUNDWATER SAMPLING FORM

1. Date/Time ____________ Sample No. ____________
2. Location ____________
3. Well No. ____________ Sketch on Back [Y or N] ______
4. Total Depth ____________ Number of Screened Interval(s) ______
5. Depth to Screen/Length(s) ____________
6. [Y or N] Well Secure? Comments ____________
7. Sampler ____________ Other present ____________
8. Organic Vapor Detector FEL No. ______, Reading ______
9. Weather: Wind ______, Precipitation ______, Air Temperature ______
10. Water Level Measurement: FEL No. ____________
    [Y or N] Well Labeled ______, Elev. Ref. For Water Level ______
    Comments ____________
    Odor ____________
11.

	Depth to Product	Depth to Interface/Water	Thickness
1st	______	______	______

12. Casing Type ______, I.D. ______, Gal/Ft. ______
    (Show derivation for gal/ft of casing)
13. Total Depth ______ - Depth to Water ______ = Ht. ______
14. Well Volume ______ = Ht. ______ * Gal/Ft. ______
15. Required Purge Volume ______, Actual Purge ______
16. FEL No.'s Cond. ______ pH ______ Temp. ______ Redox ______
17.

	Cond. µmhos/cm	pH	Temp.	Redox mv
Initial	______	______	______	______
(Purged cycle)	______	______	______	______
	______	______	______	______
	______	______	______	______
Sample	______	______	______	______

    Sample Type and FEL No. ____________
18. [Y or N] Turbid ______, Purge Water Containerized ______
19. Sample Filtered ______, Filter Size ______
20. Reviewed By ____________ Date/Time ______
    Form Complete? [Y or N] ______
    Decon Complete? [Y or N] ______

FIELD PROCEDURE FP 7-3

BOREHOLE LOGGING

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Subject	Procedure No. FP 7-3	Rev. 0	Page 1 of 6
BOREHOLE LOGGING	Issue Date 05/25/90		Effective Date 07/02/90
	Supersedes Procedure Number 630 FP 24	Rev. 0	Date
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to define the requirements necessary for borehole and sample logging. Consequently, the major objectives of this plan are to provide a uniform set of guidelines that will aid in developing consistency among sample descriptions and sample techniques. The importance of accurate, complete, clear, and concise logs cannot be overemphasized.

2.0 SCOPE

This procedure applies to descriptions of the standard techniques used for logging boreholes and logging soil/rock samples.

3.0 REQUIREMENTS

Careful field documentation and sample description is necessary to ensure that logging is done in a consistent manner.

4.0 REFERENCES

4.1 Compton, R. R., 1962. *Manual of Field Geology*, John Wiley and Sons, Inc., New York

4.2 Folk, R. L., 1968. *Petrology of Sedimentary Rocks*, Hemphills Bookstore, Austin, Texas, p. 170.

4.3 HAZWRAP, February 1989, *Quality Control Requirements for Field Methods*, DOE/HWP-69.

4.4 U.S. Army Corps of Engineers, 1953. *The Unified Soil Classification System*, Technical Memorandum No. 3-357 (Vol. 1), Waterways Experimental Station Usage, Vicksburg, MS.

4.5 Lewis, D.W., 1984. *Practical Sedimentology*, Van Nostrand Reinhold Company, Inc., NY, NY.

4.6 Pettijohn, F.J., 1975. *Sedimentary Rocks*, Harper & Row, New York.

5.0 DEFINITIONS

This section provide information that is commonly used in borehole sample descriptions (also see Section 9.0 Attachments).

Bedding - Term signifying the existence of beds or layers (strata), laminae, or other tabular and essentially horizontal units.

Cohesive - Having the capacity to stick or adhere together. In effect, the cohesion of soil is that part of its shear strength which does not depend on interparticle friction.

Color - Color should be described using a Munsell color chart, and only colors listed in that chart should be used. If the colors in the sample are variable, adjectives such as "mottled" or "banded" may be used as appropriate (available from USGS, see Attachment 9.1).

Conchoidal - Shell-like surface form produced by fracture of a brittle material.

Consistency - Consistency is the density or strength of the soil, and is a primary factor in engineering investigations (see Attachment 9.2).

Fabric - The orientation of the particles composing a soil or rock.

Friable - Easily crumbled.

Grading - Degree of mixing of size classes in a sedimentary material. Well graded implies more or less uniform distribution from coarse to fine; poorly graded implies uniformity in size or lack of a continuous distribution (also see sorting).

Grain Size - The size of particles within a rock or a soil sample (see Attachment 9.3).

Moisture - The degree of wetness of a soil, i.e. dry, damp, moist, and wet.

Plasticity - The property of a material which enables it to undergo permanent deformation without appreciable volume change or elastic rebound, and without rupture.

Slickensides - Polished and striated (scratched) surface that results from friction along a fault plane. Apparent slickensides can sometimes be created during the drilling process.

Soil Classification - see Attachment 9.7

Sphericity & Roundness - See Attachment 9.6.

Texture - Geometric aspects of the component particles of a soil or rock, including size, shape and arrangement.

6.0 RESPONSIBILITIES

6.1 Field Operations Leader

The Field Operations Leader is responsible for ensuring that field personnel have been trained in the use of this procedure, for verifying that monitoring well installation activities are performed in compliance with this procedure, and to ensure consistency in logging between Field Geologists.

6.2 Field Geologist and/or Field Technician

The Field Geologist is responsible for on-site monitoring of drilling and soil sampling operations, for recording (logging) pertinent information regarding the geologic materials

penetrated during the operations, and that the well and sample numbering system follows that described in the Quality Assurance Project Plan (QAPP).

7.0 EQUIPMENT

The following is a list of required and optional equipment necessary for borehole logging.

7.1 Required Equipment

1. Clipboard
2. Drilling record forms
3. Portable organic vapor detector
4. Field book, straight edge and black permanent ink
5. 100 foot engineer's tape (weighted)
6. Folding rule or tape measure
7. Sand gauge
8. Color chart
9. Acid bottle
10. Water level indicator
11. Site map
12. Copy of drilling contract
13. Copy of Statement of Work and/or Project Work Plan
14. Waterproof marking pen
15. Sample jars or bags

7.2 Optional Equipment

1. Hand lens
2. Brunton compass
3. Pocket penetrometer
4. Equipment pouch
5. Flagging tape
6. Cooler and water bottles

7. Flashlight

8. Rock hammer

8.0 PROCEDURE

8.1 Recording Data

Borehole information is recommended in the field logbook (See FP 1-2).

In addition to the field logbook it is required that soil logging data be recorded on a pre-printed boring log (Attachment 9.8). This activity is usually accomplished in the field office and is done to provide a clear and concise record of borehole lithology. Secondly, this method allows a rapid means in which data can be discussed and interpreted.

8.2 Information to be Gathered During Borehole Logging

Soil sampling is performed using a method such as split spoon or continuous coring. The obtained soil sample is immediately scanned with a portable organic vapor detector and the reading recorded on the log form. Selection of soil sampling intervals for chemical analysis may be based on the results of the scan with the portable organic vapor detector or by visual confirmation of contamination such as discolorization. The sampling intervals should be noted on the log form.

The percent recovery of core is noted and recorded on the log form. This number is the ratio of the actual core recovered over the interval in which the sample was taken. For instance, if a continuous core barrel goes down five feet but only four feet are retained by the core barrel, then there was an 80 percent core recovery.

The most important information on the form is the description of each sample or geologic unit. Any obvious features related to contamination should also be noted such as odor or staining. The description of lithologic samples should include color, consistency, texture, mineralogy, and moisture of the sample or unit. These characteristics should be described according to guidelines given in the attachments.

8.3 Logging Guidelines

For accuracy and consistency, boring log descriptions should generally be completed in the following order. Refer to the listed attachments for guidance.

1. Material type - Attachment 9.1, Attachment 9.4.

2. Color. Color should be described using a Munsell color chart, and the colors listed in that chart only. If the colors in the sample are variable, adjectives such as "mottled" or "banded" may be used as appropriate (Attachment 9.2).

3. Consistency. Consistency is the density or strength of the soil, and is a primary factor in engineering investigations. It is also an important part

of geologic and hydrogeologic investigations (Attachment 9.3)

4. Texture. Texture describes the size and shape of soil grains and is often the most important characteristic of a soil. The first step in describing texture is to determine whether the soil consists primarily of sand and gravel (particle size greater than 63 micrometers) or fines (particle size less than 63 micrometers). In the written description, the major soil component should be given first and be capitalized or underlined. The portions of sand, gravel and fines should be described using only the following semi-quantitative adjectives:

Adjective	Estimated Percent of Total Sample
Trace	0-5
Little	5-12
Some	12-30
And	30-50

For example - SAND, some clay. NOT Sand, lots of clay or Clayey sand. Reference Attachment 9.4

5. Description of mineralogy should be as simple as possible and above all, accurate. Relatively common mineralogic descriptions may be used as adjectives:

   Arkosic
   Calcareous
   Feldspathic
   Glauconitic
   Micaceous

   More complicated descriptions should generally be enclosed in parentheses.

6. Moisture Content. If the drilling method permits, the moisture content of the sample (dry, moist or wet) should be noted.

7. Geologic Interpretation. If the logger is familiar with the site geology and confident of the interpretation, a brief interpretation of the soil (i.e. "saprolite", "beach sand", "loess", etc.) may be added in parentheses at the end of the description. This is, of course, no substitute for a complete soil description.

9.0 ATTACHMENTS

9.1 Grain Size.

9.2 Color.

9.3 Field Criteria Used in Determining Soil Consistency.

9.4 Lithology.

9.5 Sorting.

9.6 Sphericity and Roundness.

9.7 Soil Classification Abbreviations.

9.8 Sample HAZWRAP Boring Log Form.

GRAIN SIZE

Grain Size - For consistent descriptions of grain size, the grain size classification scheme of Wentworth (1922) should be used. It is also advantageous to carry a pocket grain size card to aid in quick grain size classification in the field.

Wentworth Grain Size Classification Scheme

Exact Size Limits (mm)	Approximate inch Equivalents (in.)	Sediment
256	<10	Boulder gravel
64 - 256	2.5 - 10	Cobble gravel
32 - 64	1.2 - 2.5	Very coarse pebble gravel
16 - 32	0.6 - 1.2	Coarse pebble gravel
8 - 16	0.3 - 0.6	Medium pebble gravel
4 - 8	0.15 - 0.3	Fine pebble gravel
2 - 4	0.08 - 0.15	Granule (or very fine pebble) gravel
1 - 2	0.04 - 0.08	Very coarse sand
0.5 - 1	0.02 - 0.04	Coarse sand
0.25 - 0.5	0.01 - 0.02	Medium sand
0.125 - 0.25	0.005 - 0.01	Fine sand
0.0625 - 0.125	0.002 - 0.005	Very fine sand
0.0039 - 0.0625	0.00015 - 0.002	Silt
Smaller than 0.0039	<0.00015	Clay (clay-size materials)

COLOR

Color - The definition of color is self-explanatory; however, the Field Geologist should be aware to note both the fresh and weathered color of a soil or rock sample. Note that soils should be wet before classifying the color. For consistent descriptions of color, the Munsell color charts should be used. These are distributed by:

The Geological Society of America
Post Office Box 9140
Boulder, CO 80401

For mixed lithologies within a common interval, provide relative percentages of the two or more lithologies within parentheses following the lithologic name. For example, SAND fine - medium (60%) brownish yellow (10YR6/6), and GRAVEL coarse (40%) - very pale brown (10YR7/3), etc. (HAZWRAP, 1989).

COMMONLY USED CRITERIA FIELD CRITERIA USED FOR DETERMINING SOIL CONSISTENCY

SOIL CONSISTENCY AS DETERMINED BY POCKET PENETROMETER

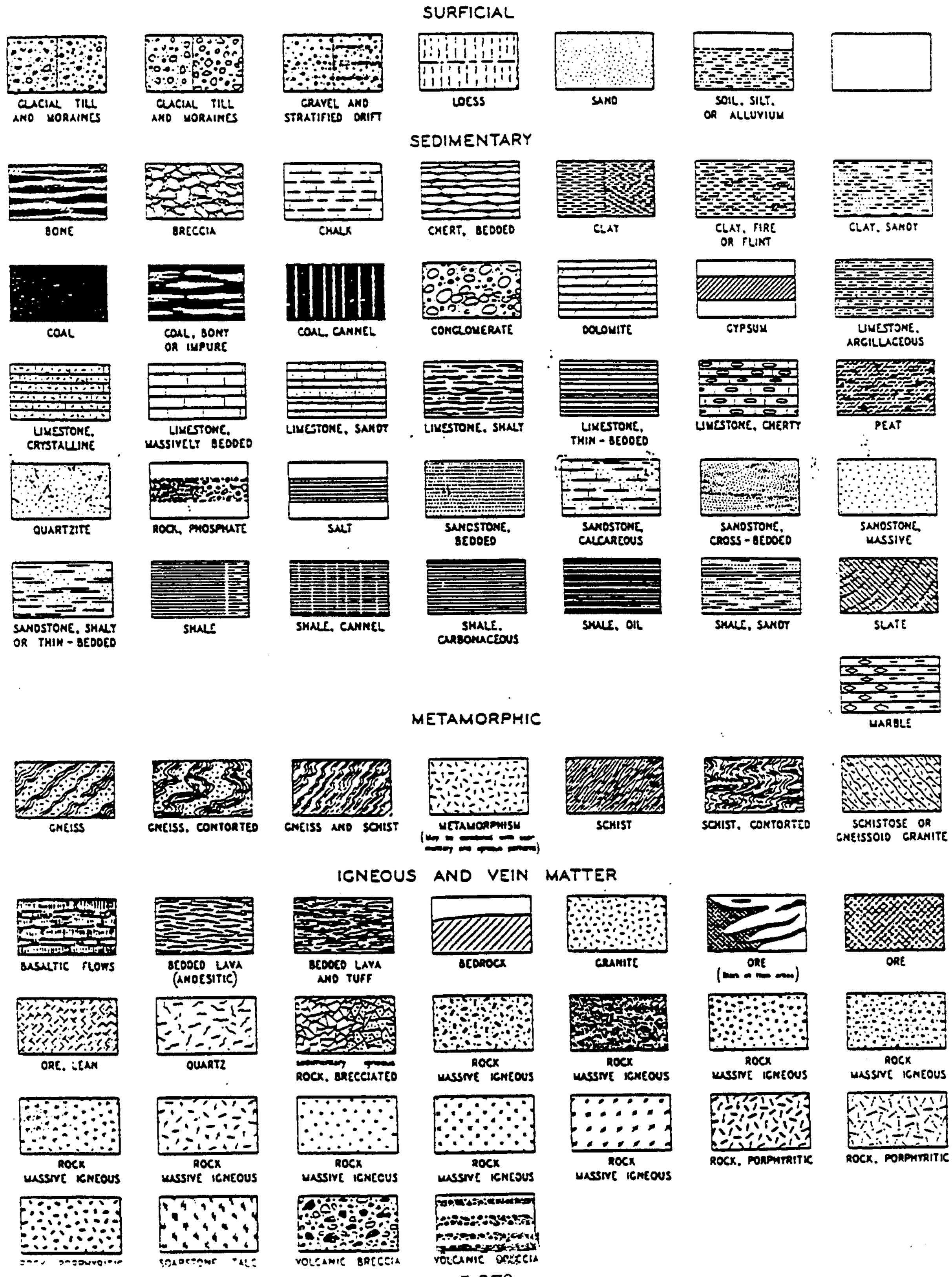
	Unconfined Compressive Strength of Fine Grained Soils (AFter Terzaghi and Peck)		Field Test (After Cooling, Skempton, and Glossip)
Term	Kips/ft^2	kN/m2	
Very soft	0-0.5	0-25	Squeezes between fingers when fist is closed.
Soft	0-5.1	25-50	Easily molded by fingers
Firm	1-2	50-100	Molded by strong pressure of fingers.
Stiff	2-3	100-150	Dented by strong pressure of fingers.
Very Stiff	3-4	150-200	Dented only slightly by finger pressure.
Hard	4+	200+	Dented only slightly by pencil point.

COMMONLY USED CRITERIA FIELD CRITERIA USED FOR DETERMINING SOIL CONSISTENCY (Continued)

Consistency of Fine Grained Soils - Standard Penetration Test (After Terzaghi and Peck)		Relative Density of Sand Standard Penetration Test (After Terzaghi and Peck)	
Blows 6-inch Penetration	Consistency	Blows 6-inch Penetration	Relative Density
0-1	Very soft	0-5	Very loose
2-4	Soft	5-10	Loose
5-8	Firm	11-20	Firm
9-15	Stiff	21-30	Very firm
16-30	Very Stiff	31-50	Dense
31+	Hard	51+	Very dense

ATTACHMENT 9.4
FP 7-3

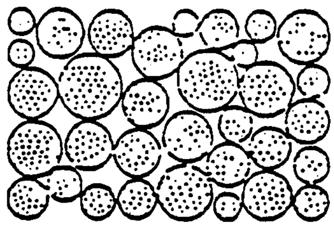
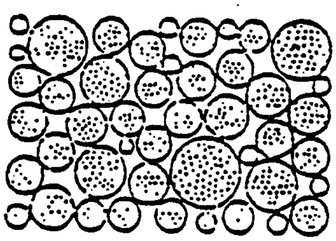
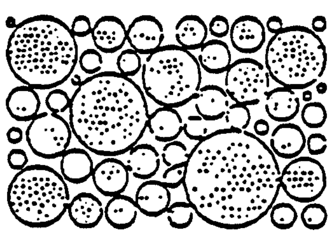
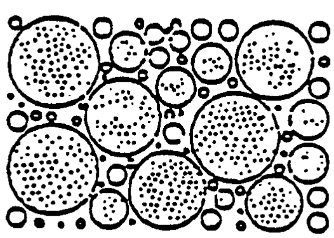
COMMON SYMBOLS USED IN THE LITHOLOGIC DESCRIPTION OF SOIL AND ROCK SAMPLES



ATTACHMENT 9.5
FP 7-3

SORTING

The generally accepted standard for describing the degree of sorting in a soil or rock sample is based on the Folk Classification Scheme, 1968.

Visual Standard	Phi standard deviation	Verbal
	0.35	
		0.35 - 0.50 well sorted
	0.50	
		0.50 - 1.0 moderately sorted
	1.00	
		1.0 - 2.0 poorly sorted
	2.00	
		>2.00 very poorly soorted

SPHERICITY AND ROUNDNESS

Sphericity is a mesure of how nearly equal the axial dimensions of a particle are. True sphericity is the surface area of a grain divided into the surface area of a sphere of the same volume.

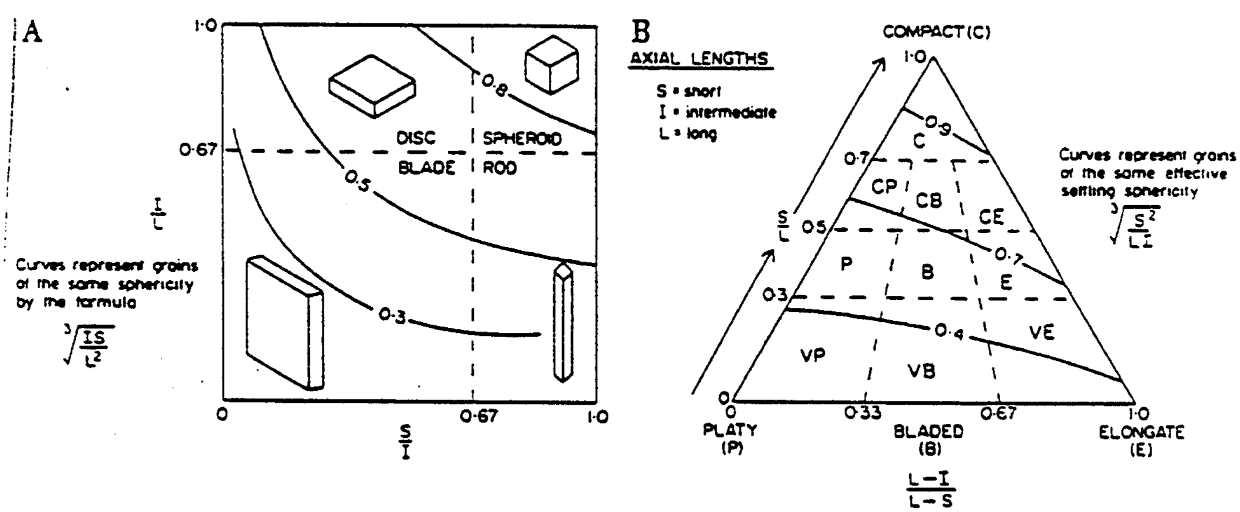
Operational sphericity is:

$$\sqrt[3]{\frac{Vp}{Vcs}}$$

where Vp = volume of particle and Vcw = volume of smallest sphere that would enclose the particle. Vcs is approximated by

$$\sqrt[3]{\frac{LIS}{L^3}} = \sqrt[3]{\frac{IS}{L^2}}$$

where I = intermediate axis, S = short axis, and L = long axis.



SPHERICITY AND ROUNDNESS (Continued)

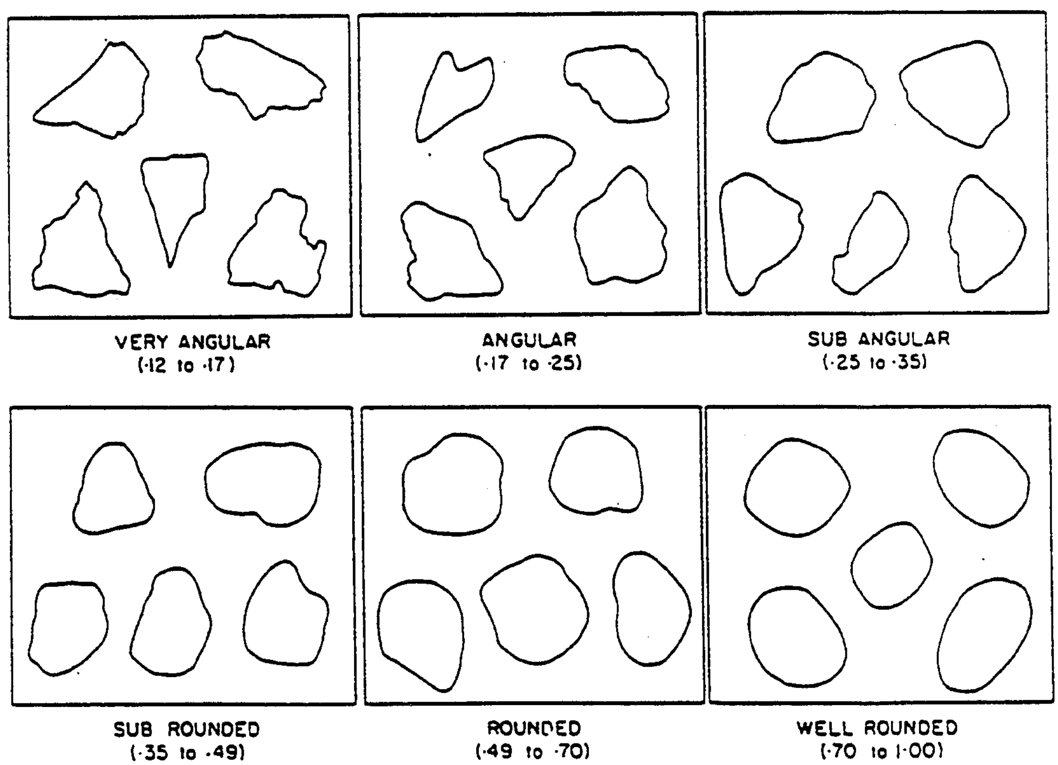
Roundness indicates the extent of abrasion the grains have undergone. Extent of abrasion reflects overall transport history but does not necessarily reflect the distance the grains have traveled from their source - rounded grains may have been derived locally from a sedimentary rock, or may have been extensively abraded in an environment near the source, such as a beach adjacent to a cliff.

Quantitatively, true roundness is generally expressed by the formula:

$$\Sigma \frac{r}{R} N$$

where r - radius of curvature of grain corners, R - radius of largest *inscribed* circle, and N - number of corners.

Unless highly detailed work is justified by the likely results, practical measures of roundness rely on visual comparison with standard silhouette charts.



Silhouette comparison diagram for sand grain roundness.

SOIL CLASSIFICATION ABBREVIATIONS

The following is a list of modifiers that are commonly used to characterize the gross lithology of a soil sample. The list if after the Unified Soil Classification System (USCS) scheme.

C -	Coarse	BR -	Broken
Med -	Medium	BL -	Blocky
F -	Fine	M -	Massive
V -	Very	Br -	Brown
Sl -	Slight	Gn -	Green
Sm -	Some	Gr -	Gray
Occ -	Occasional	Bk -	Black
Tr -	Trace	Yl -	Yellow
Lt -	Light	Or -	Orange
Dk -	Dark	Rd -	Red
		Bl -	Blue
		Tn -	Tan
		Wh -	White

SAMPLE HAZWRAP BORING LOG FORM

REV. DATE: JAN 1989

BORING LOG	BORING/WELL NO.:		Page ____ of ____
Installation:		Site:	
Project No.:	Client/Project:		
HAZWRAP Contractor:	Drlg Contractor:		Driller:
Drlg Started: (: __m)	Drlg Ended: (: __m)		Borehole dia(s):
Drlg Method/Rig Type:			
Logged by:	E-Log (Y/N) From ______ to ______		Protection Level:

Depth (ft)	Sample	Sample No.	Lab Anal. (Y/N)	ndsp	Recovery	Lithologic Description	USCS	Blows/6 inch.	Graphic Log	Well data	Water depth & Remarks	El

U = Thin wall tube
S = Split spoon (tube)
C = Cuttings

R = Rock coring ________
O = Other ________
Notes: ________

Field G/C (Make/Mod.) ________
G/C Oper.: ________

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FIELD PROCEDURE FP 7-4

PH MEASUREMENTS

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Subject	Procedure No. / Rev.	
	FP 7-4 / 0	Page 1 of 3
pH MEASUREMENTS	Issue Date: 05/25/90	Effective Date: 07/02/90
	Supersedes Procedure Number: 630 FP 30 / Rev.: 0	Date:
Acceptance - Program QA	Approval - Program Manager	

1.0 PURPOSE

The purpose of this procedure is to define the necessary steps for conducting pH measurements during field activities.

2.0 SCOPE

2.1 This procedure applies to the calibration, operation and maintenance of the Omega Model PHH-60/80 hand-held pH meter and probe.

2.2 This procedure may also be used in conjunction with the manufacturer's instructions for other pH measuring devices.

3.0 REQUIREMENTS

pH is an important environmental parameter that is routinely measured during waste management investigations to provide information on the extent of contamination at a site. In addition, pH measurements are taken on purge waters from monitoring wells to aid in assessing when sufficient water has been removed from the well to ensure that formation water samples will be collected.

4.0 REFERENCES

OMEGA Engineering, Inc., Model PHH 60/80 Hand Held pH Meter Instruction Manual, 1986.

5.0 DEFINITIONS

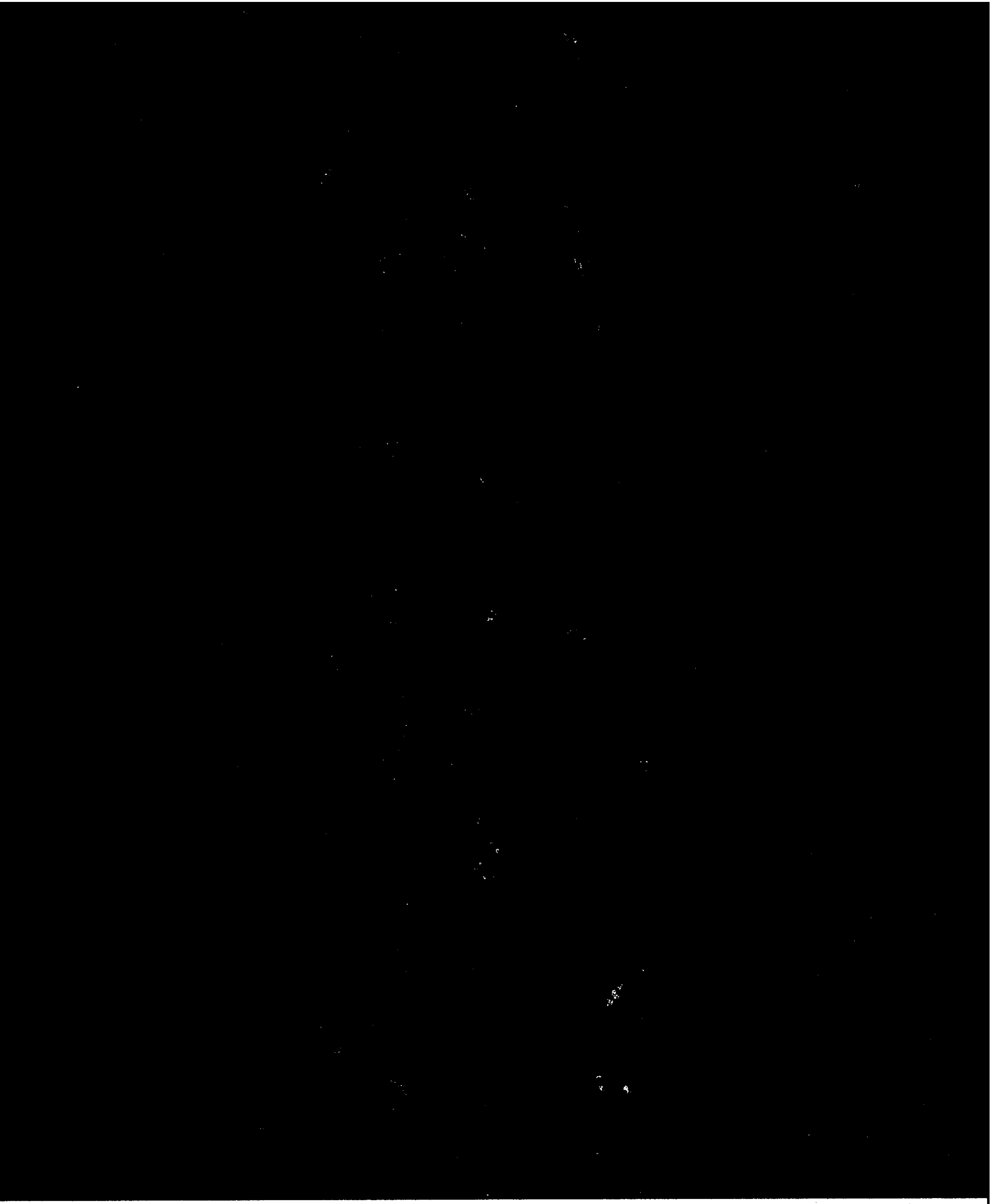
None.

6.0 RESPONSIBILITIES

The Field Operations Leader is responsible to ensure that the necessary equipment is available for the calibration, use and maintenance of measuring equipment. The Field Operations Leader is also responsible to ensure that the calibration and use methodology is consistent and that workers have been instructed in the proper use of equipment.

7.0 EQUIPMENT

7.1 OMEGA Model PHH 60/80 hand held pH meter and probe, or equivalent.



6. Select the desired parameter by depressing pH/PPM switch.
7. Agitate electrode briefly and observe reading.
8. Rinse electrode thoroughly with ASTM Type II reagent-grade water and replace pH storage cap; fill the cap with a small amount of pH 4 buffer or potable water to keep the bulb from drying out.
9. Remove the battery when the instrument will be stored for a long period.

8.3 Preventive Maintenance

The pH meter should be cleaned and inspected daily before and after use. Batteries shall be replaced, as necessary and the pH electrode shall be replaced when required.

The pH electrode can be maintained by cleaning after use with ASTM Type II reagent-grade water and filling the electrode's protective cap with a small amount of pH 4 buffer or potable water to keep the bulb from drying out.

9.0 ATTACHMENTS

None.

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FIELD PROCEDURE FP 7-5

SPECIFIC CONDUCTIVITY MEASUREMENTS

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Subject	Procedure No.	Rev.	
	FP 7-5	0	Page 1 of 5
SPECIFIC CONDUCTIVITY MEASUREMENTS	Issue Date 05/25/90		Effective Date 07/02/90
	Supersedes Procedure Number 630 FP 31	Rev. 0	Date
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to define the steps necessary for calibration, operation and maintenance of the Hach Model 44600 conductivity/TDS meter.

2.0 SCOPE

2.1 This procedure applies to the calibration, operation and maintenance of the Hach Model 44600 conductivity/TDS meter.

2.2 This procedure may also be used in conjunction with the manufacturer's instructions for other specific conductivity meters.

3.0 REQUIREMENTS

Electrical conductance of a substance is its ability to conduct an electrical current. Chemically pure water has a low electrical conductance; while water that contains dissolved inorganic solids (chloride, phosphate, etc.) has a high electrical conductance. Consequently, the greater the amount of dissolve solids in ground water the greater the water's electrical conductivity.

4.0 REFERENCES

4.1 Driscoll, F. G., 1986. *Groundwater and Wells*. Johnson Division, St. Paul, Minn. pp. 92-94.

4.2 Hach Model 44600 Conductivity/TDS Meter Instruction Manuals.

5.0 DEFINITIONS

None.

6.0 RESPONSIBILITIES

The Field Operations Leader is responsible to ensure that the necessary equipment is available for the calibration, use, and maintenance of the sampling equipment. The Field Operations Leader is also responsible to ensure that the calibration and the method of operation is consistent and that workers have been instructed in the proper use of equipment.

7.0 EQUIPMENT

The following is a list of replacement parts, calibration standards and accessories associated with the operation of the Hach Model 44600 conductivity/TDS meter.

REPLACEMENT PARTS AND ACCESSORIES

Cat. No.	Description	Unit
19380-04	Battery, AA, alkaline	4/pkg
1080-42	Beaker, poly, 100 mL	each
620-14	Bottle, wash, 120 mL	each
14423-26	Gallic Acid Solution, 59-Ml dropping bottle	each
44600-88	Instruction Manual	each
162-36	Phenolphthalein Indicator Solution	15 mL
44606-00*	Probe, conductivity	each
44606-10*	Probe, conductivity, 10-ft cable (optional)	each
2105-14	Sodium Chloride Standard Solution, 100 mg/L (1990 $\pm$ 20 μS/cm, 995 $\pm$ 10 TDS)	118 mL
23075-14	Sodium Chloride Standard Solution, 85.47 mg/L (180 $\pm$ 00 μS/cm, 90 $\pm$ 10 TDS)	118 mL
14400-14	Sodium Chloride Standard Solution, 491 mg/L (1000 $\pm$ 10 μS/cm, 500 $\pm$ 5 TDS)	118 mL
23074-14	Sodium Chloride Standard Solution, 10246 mg/L (18000 $\pm$ 50 μS/cm, 9000 $\pm$ 25 TDS)	118 mL

*Refer to specifications for differences in accuracy and zero error.

8.0 PROCEDURE

The procedure for calibration, operation, and maintenance of the Hach Model 44600 conductivity/TDS meter is outlined below. If using a different instrument, the owner's manual should be consulted for instructions.

8.1 Calibration

Calibration will be needed periodically due to aging of the probe electrical components or when a new probe is installed. Calibration with a standard solution of known conductivity value near the typical temperature of the sample solution will improve accuracy.

NOTE: Calibration on the 2 mS/cm range with the 100 mg/L NaCl (1.99 mS/cm) standard calibrates all three ranges accurately enough for most applications. However, slightly better accuracy will be gained by calibrating on the particular range to be used using the appropriate standard solution. *Refer to Replacement Parts and Accessories* for a list of available standards offered by Hach Company.

Calibrate as follows:

NOTE: Sodium Chloride standards are contaminated easily. Always clean the probe before calibration and use a clean, dry container for the standard solution.

1. Be sure the probe is clean.
2. Soak the probe in demineralized water for at least 30 minutes.
3. Remove the probe from the water and fling out drops clinging inside.
4. Immerse the probe to or beyond the vent holes in a beaker containing Sodium Chloride Standard Solution, 1000 mg/L. Agitate vertically to remove entrapped air.
5. Repeat Steps 3 and 4 at least once more.
6. Press the POWER I key and CND key. Verify that the LO BAT indication does not appear.
7. Press the 2 mS/cm range key.
8. Check the reading on the display. It should be 1.990 mS/cm. If adjustment is needed, use a small screwdriver to adjust the CAL control next to the display. Counterclockwise adjustment increases the reading.

8.2 Operation

Taking the Conductivity Measurement:

If the probe has been in storage, soaking may be necessary prior to use to ensure the probe is thoroughly wetted.

1. Press the POWER I key and CND key. Verify that the LO BAT indication does not appear.
2. Select the appropriate range. If the range in unknown, begin with the highest range.
3. Insert the probe into the sample solution. Immerse the tip to or beyond the vent holes and agitate the probe vertically to be sure air bubbles are not entrapped. Allow time for the reading to stabilize. If the reading falls within the lowest 10% of the range, select the next lower range and again allow the reading to stabilize before recording the measurement. An overrange condition cause a 1 display followed by blank digits.
4. Rinse the probe thoroughly with demineralized water after each measurement.

Taking the Total Dissolved Solids Measurement:

1. Press the POWER I key and CND key. Verify that the LO BAT indication does not appear.
2. Select the appropriate range. If the range in unknown, begin with the highest range.

3. Insert the probe into the sample solution. Immerse the tip to or beyond the vent holes and agitate the probe vertically to be sure air bubbles are not entrapped. Allow time for the reading to stabilize. If the reading falls within the lowest 10% of the range, select the next lower range and again allow the reading to stabilize before recording the measurement.

Taking the Temperature Measurement:

1. Press the POWER I key and °C key. Verify that the LO BAT indication does not appear.

2. Insert the probe into the sample solution. Immerse the tip to or beyond the vent holes and agitate the probe vertically if the sample is not flowing or being stirred to be sure air bubbles are not entrapped near the temperature sensor. Allow the reading to stabilize before recording the temperature measurement.

3. Rinse the probe thoroughly with demineralized water after each measurement.

8.3 Preventive Maintenance

Cleaning the Probe:

The probe should be rinsed thoroughly with deionized water between measurements during normal use. When this is done there will be little chance of interfering substances building up on the probe elements. Should the sample contain oils, greases or fats, however, the electrodes could become coated and affect accuracy of the readings. In this case, the probe should be cleaned with a strong detergent solution or dipped in a 1:1 hydrochloric acid solution and then rinsed thoroughly with deionized water.

Battery Replacement:

A low battery indication will appear in the upper left corner of the display when battery replacement is needed. Replace the complete set as described in the Battery Installation procedure in the Preparation for Use section.

Probe Replacement:

The replacement probe assembly listed in the replacement parts list comes with the cable and the 4-circuit connector installed and with the cable tie properly positioned four inches from the connector. Replace the probe assembly as follows:

1. Remove the batteries from the battery holder.

2. Remove the six screws securing the instrument in the case.

3. Carefully lift the instrument from the case.

4. Disconnect the probe cable connector from the circuit board jack.

5. Connect the replacement probe cable connector to the circuit board jack and install the instrument in its case. Be sure the cable tie installed on the probe cable is placed inside the compartment housing the circuit boards to provide a strain relief for the probe cable.

6. Secure the instrument in the case with the six screws removed in Step 2. Thread the screws until the heads contact the panel surface. Screws will not become tight with further rotation, but threads will not strip.

7. Replace the batteries. *Refer to Battery Installation.*

8. Perform calibration with the new probe. *Refer to the Calibration paragraph.*

9.0 ATTACHMENTS

9.1 Attachment 9.1 - Description and Location of Controls and Indicators.

DESCRIPTION AND LOCATION OF CONTROLS AND INDICATORS

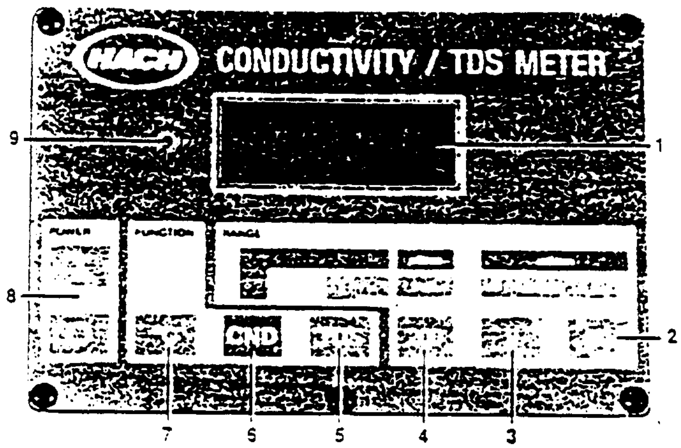

Table 1 Instrument Controls

Item	Name	Description
1	Liquid Crystal Display	A 3 1/2-digit display indicates value of measurement. Readout will be in millisiemens per centimeter, microsiemens per centimeter, grams per liter total dissolved solids, milligrams per liter total dissolved solids or degrees celsius, depending on the function and range switches selected. A low battery indication is incorporated, indicating LO BAT when battery replacement is required.
2	20 Range Key	Selects range 20 for mS/cm conductivity or g/L total dissolved solids.
3	20 Range Key	Selects range 2 for mS/cm conductivity or g/L total dissolved solids.
4	200 Range Key	Selects range 200 for μS/cm conductivity or mg/L total dissolved solids.
5	TDS Key	Selects total dissolved solids measurement mode.
6	CND Key	Selects conductivity measurment mode.
7	°C Key	Selects temperature measurement mode.
8	Power Keys	Turns operating power on and off. Press I for on, O for off.
9	CAL Control	Used to calibrate the cell constant setting to compensate for variations in probe electrical characteristics.

FIELD PROCEDURE FP 7-6

STREAM FLOW MEASUREMENTS

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Subject	Procedure No. FP 7-6	Rev. 0	Page 1 of 7
STREAM FLOW MEASURMENTS	Issue Date 05/25/90		Effective Date 07/02/90
	Supersedes Procedure Number 630 FP 3	Rev.	Date
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to describe methods, sequence of operations, and equipment necessary to determine the cross-sectional area and flow of a stream.

2.0 SCOPE

This procedure applies to methods used in determining stream flow and cross-sectional configurations.

3.0 REQUIREMENTS

Since the physical characteristics that streams exhibit vary widely, it is necessary to present several methods and techniques that can be used to calculate channel areas and flow rates.

4.0 REFERENCES

4.1 Boyer, M.C., 1964. "Streamflow Measurement," *Handbook of Applied Hydrology*, McGraw-Hill, pp. 15-1 to 15-41.

4.2 Chow, Ven Te, 1959. *Open-channel Hydraulics*, McGraw-Hill, p. 680.

4.3 Collings, M.R., 1968. "Selection of dye-injection and measuring sites for time-travel studies," *U.S. Geological Survey Water-Supply Paper*, 1892, p. 23-29.

4.4 Dalrymple, Tate and Benson, M.A., 1967. "Measurement of peak discharge by the slope-area method," *U.S. Geological Survey Techniques of Water Resources Investigation*, Book 3, Chapter A9.

4.5 Horton, Robert E., 1907. "Weir experiments, coefficients, and formulas," *U.S. Geological Survey Water Supply Paper 200*, p. 195.

4.6 Kilpatrick, F.A., 1968. "Flow calibration by dye-dilution measurement," *Civil Engineer*, v. 38, No. 2, pp. 74-76.

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4.8 Replogle, J.A., Meyers, L.E. and Brust, K.J., 1966. "Flow Measurement with

fluorescent tracers," *American Society of Civil Engineering Proceedings*, Journal of the Hydraulics Division, V. 92, No. HY5, pp. 1-15.

4.9 Robinson, A.R. and Chamberlain, A.R., 1960. "Trapezoidal flumes for open-channel flow measurement," *ASAE*, Vol. 3, No. 2.

4.10 Searcy, James K., 1959. "Flow-duration curves," *U.S. Geological Survey Water Supply Paper* 1542-A, p. 33.

4.11 Smart, P.L. and Laidlaw, I.M.W.,1977. "An evaluation of some fluorescent dyes for water tracing," *American Geophysical Union, Water Resources Research*, Vol. 13, No. 1, pp. 15-33.

4.12 Smoot, G.F., 1974, "A review of velocity-measuring devices," *U.S. Geological Survey Open-File Report*, p. 35.

4.13 USGS, 1977. *National Handbook of Recommended Methods for Water-Data Acquisition*, Volume I, USGS, Office of Water Data Coordination, Reston, VA.

4.14 Wilson, James F., Jr., 1968. "Fluorometric procedures for dye tracing," *U.S. Geological Survey Techniques Water-Resources Investigation*, Book 3, Chapter A12, p. 31.

5.0 DEFINITIONS

5.1 Flow (or volumetric flow rate)

The volume of water which passes through a cross-sectional plane in some unit of time. (Syn. - DISCHARGE)

5.2 Flume

An artificial channel used for constricting the flow of wastewater or water in order to promote laminar flow for the purpose of measuring flow volume.

5.3 Stage

The height of a water surface above an arbitrarily established datum plane.

5.4 Weir

A levee or dam-type structure containing a notch trough which the flow of water can be measured and regulated.

6.0 RESPONSIBILITIES

6.1 Project Manager

In consultation with the project hydrogeologist, is responsible for determining the optimum location for performing flow determinations within an open channel to include the selection of the appropriate methodology, technique and field procedure for conducting the field test.

6.2 Field Operations Leader

Responsible for direct supervision of the installation and execution of the field test to determine flow in an open channel. This individual is responsible for inspection of the equipment to ensure its adequacy for performance, preparation of the site and execution and performance of the test.

7.0 EQUIPMENT

Equipment required will vary depending upon method of cross-sectioning and flow measuring selected.

8.0 PROCEDURE

8.1 General

The discussion below addresses the various methods and techniques used to measure cross-section and stream velocities with respect to the velocity-area open channel technique of stream flow measurement. These techniques should be applied whenever stream gaging information is not available. When possible, stream gaging station information will be utilized since, real time flow information can be obtained from the authority responsible for the station.

The most common method of open channel flow determination is the velocity-area method. In this method, a flow or discharge measurement is computed as the summation of the products of partial areas of the flow cross-section and their respective average velocities. This is represented by the formula:

$$Q=\Sigma(av)$$

where:

Q = total discharge,

a = individual partial cross-sectional area, and

v = corresponding mean velocity normal to the partial area.

8.2 Cross Sectional Area Determination

Width Determination

Width determination for shallow streams and brooks is accomplished by a simple tape measurement. However, when streams or rivers are wide (greater than 100 feet), deep (greater than five feet), or exhibit a high flow velocity, width determination is a problem. As a general rule, width determinations under these conditions accuracy will be to the nearest foot for 100-foot streams. Tape measurement of streams or rivers is accurate enough for streams up to 500 feet in width; however, for large streams, alternatives may be required. Bridges are

convenient avenues across which measurements can be made. An equally acceptable method of determining width will be by transit and stadia survey techniques.

Depth Determinations

Most often, depth measurements are taken directly with a measured rod or sounding weight. The mass of the weight suspended at the end of the tape should be sufficient to keep the tape essentially vertical. For high velocity streams or excessively deep channels, a sonic sounder is most appropriate, since some can be adapted to produce a continuous strip chart profile of the channel depth.

8.3 Velocity/Flow Determinations

As a general practice, the actual measurement of depth, width and velocity would normally occur concurrently. The methods specified below refer to open channel stream flow where continuous long-term measurements will not be required. Zero flow or non-channel flow conditions (overland flow) are not discussed within this text and require special procedures for flow determination. The main parameters to be collected for open channel flow determinations will be cross-sectional area and stream velocity.

8.3.1 Stream Gaging Stations

A network of stream gaging stations has been in place for several decades. The authorities responsible for their placement will be the U.S. Army Corps of Engineers, USGS, and other Federal or state agencies. In general, they have been placed in sensitive watershed areas and along major tributaries and rivers throughout the United States.

These stations have established water stage-discharge relationships ("rating curves") which allow flow to be determined from water stage measurements. By measuring water directly from the staff gage and applying that value to the rating curve for that station, flow is easily determined. The rating curve will be maintained by the operator of the gaging station. If a new gaging station is established, the techniques outlined in the USGS publication "Discharge Measurement and Computation", Book I, Chapter II, United States Department of the Interior, Geological Survey, 1965 will be used.

8.3.2 Current Meters

Current meters provide a quick and relatively accurate method of determining flow under existing site conditions. They are generally not used for long-term determinations. There are many types of current meters: mechanical, electrical, vertical shaft, and horizontal shaft. The type preferred for open channel stream measurement are those which have a vertical shaft. The basic concept of a current meter is that of a rotating element at the end of the vertical shaft (or, in some cases, stationary electrodes) is submerged beneath the stream's

surface where the flow of water rotates the element (or passes between the electrodes). The speed of rotation of the element (or flow between the electrodes) measured directly by the current meter which is then correlated to stream flow velocity through the meter's own electronic circuitry or by graphs or charts which accompany the instrument. Speed is normally measured in meters/second or feet/second. Current meters will generally measure flow down to 0.03 meters/sec (0.1 ft/second). Current meters which use electrodes may be utilized for measuring streams that have weedy growths emanating from the stream bottom which would affect the rotation element. The depth to which current meters can be used will only be limited by the ability to hold the unit rigid at depth. Once a current meter value is taken, the measurement will be averaged with other measurements taken along a vertical transect of the stream at that point to determine the mean velocity along that vertical transect. In a wide stream, several vertical transects can be constructed such that less than 10 percent of the volume of the stream will be represented by each transect. The mean stream velocity can be calculated as the average of the individual average vertical velocities of each transect, with each average velocity weighted by the cross-sectioned area of the stream that it represents. Some of the methods by which a current meter can be used are as follows:

- **Six-tenths Method** - This method will be best utilized when the depth of the stream is less than 0.8 meters (2.6 feet) but greater than 0.1 meters (0.3 feet). In general, current meters should not be used when depth of streams are less than 0.1 meters (0.3 feet). This method will be best utilized when flow information must be gained relatively quickly or in a shallow stream (<0.8 meters). In this total depth below the surface along each of the vertical accuracy, each measurement within each transect should be taken three times and the result averaged to determine the mean velocity along that transect. This method will reduce the effects of aberrant measurements.

- **Two-point Method** - This method should only be used for streams exhibiting a depth greater than 0.8 meters (2.6 feet). This restriction will be due to the effects that the surface of the stream and stream bed would have on the rotating element. In this method, measurements will be taken at 0.2 and 0.8 of the total depth below the surface. The two measurements will then be averaged to obtain the mean velocity along the vertical transect. Then all the transects will be averaged to determine the stream flow.

- **Three-point Method** - This method will be restricted to those streams exhibit a depth greater than 0.8 meters (2.6 feet). In this method, velocities will be determined with a current meter at 0.2, 0.6, and 0.8 of the total depth below the surface. The 0.2 and 0.8 readings should be averaged. The result will then be averaged with the 0.6 reading. This method will be very effective in those streams in which the vertical velocities are not normally distributed.

- **Vertical-velocity Method** - This method should be primarily used for deep channels. In this method, readings will be taken at 0.1 depth increments starting at 0.1 and ending at 0.9. These values will then be averaged to determine the mean velocity of the vertical. Due to the numerous readings required, this method should not be often used.

8.3.3 Deflection or Drag-body Methods

This method will utilize the relationship that drag is proportional to the square of the velocity. This method will tend to be insensitive to very low velocities and will also be affected by aquatic growth or debris which can affect the drag coefficient of the body utilized. This method will be, however, relatively inexpensive and, under certain conditions, will yield as accurate a result as any device.

8.3.4 Floats

Floats operate on the principle that velocity of the stream can be determined by measuring the velocity of a float carried on the surface of the stream. If the stream is wide enough to require several velocity measurements, several floats should be used, with the resulting velocity multiplied by the fraction of the cross-sectional area of each represented measurements. The sum of the products will equate to the flow or total discharge of the stream. There are many types of floats and each has its own coefficient to obtain mean velocity from a surface velocity measurements.

8.3.5 Pressure Methods

Pressure methods use a device called an impact tube to measure stream velocity. The impact tube come in several different varieties, i.e., the Pitot, Barcy, Prandtl, or Brabbe tubes. Impact tubes operate through the principle that velocity is proportional to the square root of the dynamic pressure head which is either measured directly or as a difference between the total and static pressure head in these impact tubes.

8.3.6 Tracer Methods

Several types of tracers including salt, dye, or radioisotopes are used in this method. The major objection to this type of velocity measurement are that pools and eddies tend to trap the tracer. Therefore, a uniform cross-sectional portion of the stream channel must be used. The tracer must be introduced as a slug into the stream channel. This can either be at one point or simultaneously at many points across the stream. The tracer concentration should be measured at one or more points at known distances downstream of the injection point. At each of the downstream points, concentration/time curves are created by continuous measurement. The most precise determination of average velocity can be made by using the centroid of the concentration/time curve to measure the travel time; however, the

measurement of time at the concentration peaks will be nearly as accurate.

8.3.7 Weirs and Flumes

A considerably more sophisticated method of determining stream flow is through the installation of artificial, pre-calibrated control structures such as weirs and flumes. A weir is a dam-like structure behind which the water is ponded. The top of the weir contains a calibrated notch through which the ponded water eventually flows. Stream flow should be determined by measuring the height of flow through the weir, which is a function of potential energy behind the overfall. A flume is basically a constricted flow structure which provides a uniform cross-section for measurement of flow. Flow should be determined within the superficial section within the throat of the constriction. For a detailed discussion of weirs and flumes, see U.S. Geological Survey (1977), Volume 1, Chapter 1, p 1-65 to 1-77.

9.0 ATTACHMENTS

None.

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APPENDIX J

Geotechnical Analysis Results

ENVIRONMENTAL EXPLORATION INC.

Corporate Office
620 Red Oak Road
Stockbridge, Georgia 30281
(404) 389-0475
FAX:(404) 389-0675

Northern Virginia Office
Route 2, Box 4517
Berryville, Virginia 22611
(703) 955-1922
FAX: (703) 955-1095

June 30, 1992

SAIC
1710 Goodridge Drive
MS 2-4-1
McLean, Virginia 22102

Attn: Mr. Al Wickline

RE: RESULTS OF GEOTECHNICAL LABORATORY
SERVICES FOR OHIO NATIONAL GUARD
SITES IN SPRINGFIELD AND CINCINNATI
SUBCONTRACT NO. 38-930024-42
EEI PROJECT NO. 91019

Gentlemen:

EEI has completed the requested geotechnical laboratory work for this project requested as of this date. Included are six Grain Size Analyses presented as Grain Size Distribution Curves; three Permeability Tests presented on the Grain Size Distribution sheets; three Consolidation Tests presented as Consolidation Test Data curves; six Atterberg Limit Tests presented on the Grain Size Distribution sheets; and six moisture contents presented on the Grain Size Distribution sheets.

We have appreciated the opportunity to serve your needs on this project to date. If you have any questions or if we may be of further service in any way, please do not hesitate to contact this office at your convenience.

Respectfully submitted,

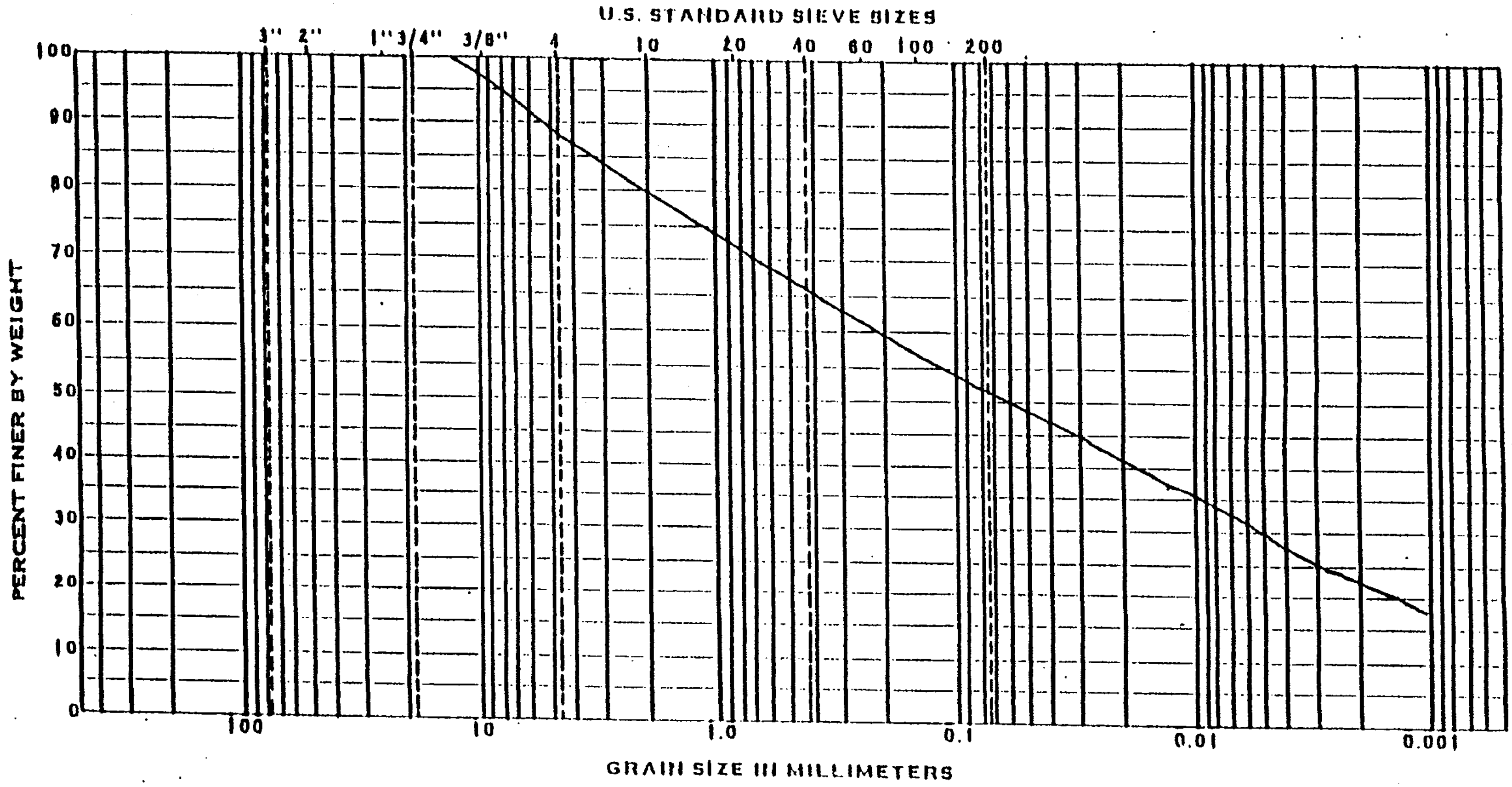
Ben W. Keeler

Ben W. Keeler, P.E.

BWK:nrb

Enclosures

CGC Chattahoochee Geotechnical Consultants



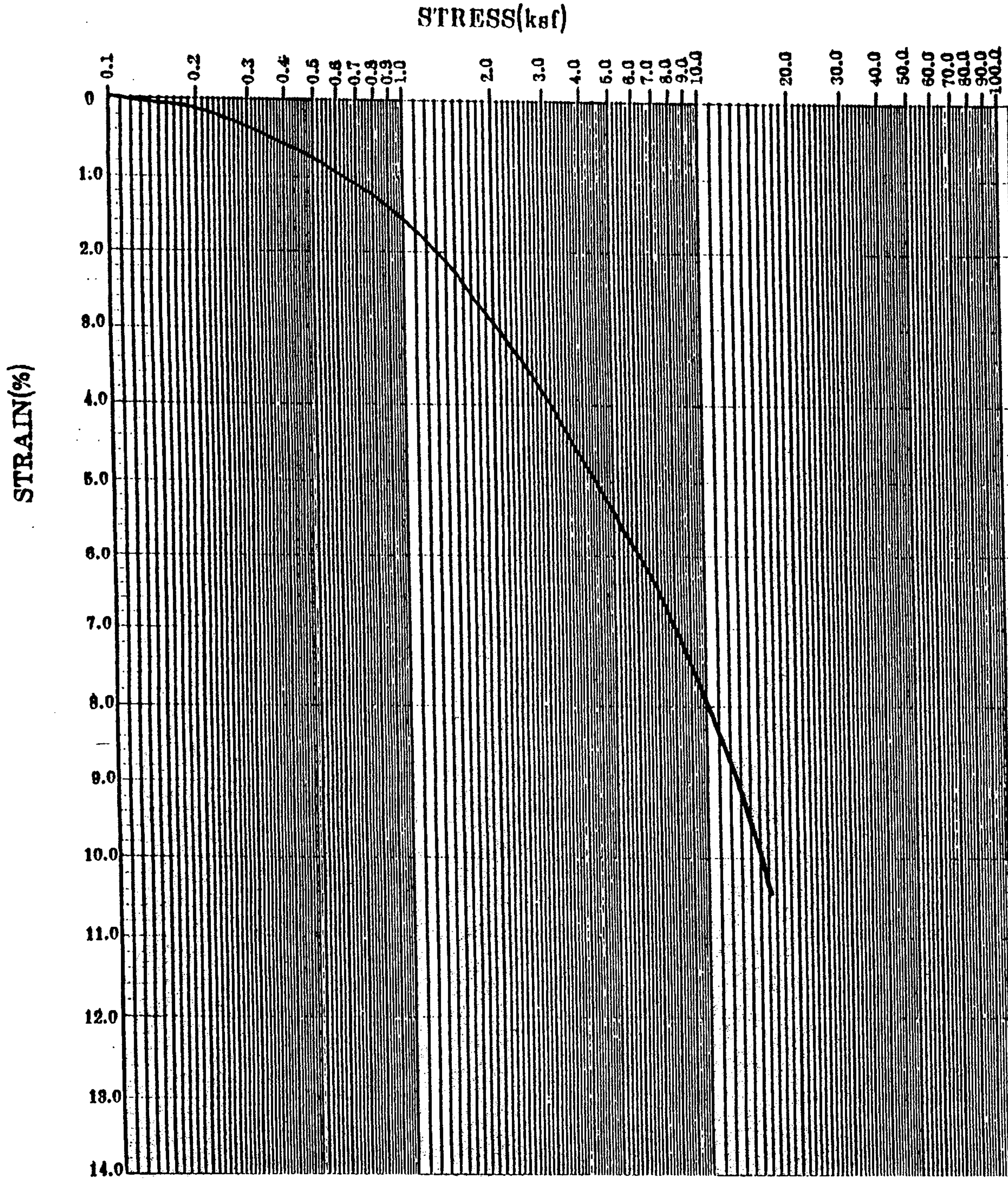
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
P-2 Blue Ash	8-10	12.9	55	25	29	Clayey Sandy SILT, Brown, Some Gravel. (MH) Back Pressure Saturated Coefficient of Permiability $K=1.4 \times 10^{-8}$ cm/sec

GRAIN SIZE DISTRIBUTIO

Project: Ohio National Guard
Project #: 92-233.17
Client: EEI
Date: 6-29-92

CGC CHATTAHOOCHEE GEOTECHNICAL CONSULTANTS



CONSOLIDATION TEST DATA

PROJECT: Ohio National Guard

PROJECT No: 92-233.17 SAMPLE No: P2 8'-10' Blue Ash

ATTERBERG LIMITS	LL	PL	PI
	55	25	29

	MOISTURE (%)	WET UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)
INITIAL CONDITIONS	12.9	126.1	111.6
FINAL CONDITIONS	11.2	132.4	119.1

Back Pressure Saturated Coefficient of Permeability $K = 1.4 \times 10^{-8}$ cm/sec.

X.

Project Name	OHIO NATIONAL GUARD, SPRINGFIELD			Date	25-Jun-92
Job Number	92-233.17			Boring	
Sample Number	P-2			Depth	
Height	1.16			Diameter	2.37

w/ci	12.9%	wi	126.0588	di	111.62090
w/cf	11.2%	wf	132.3544	dc	119.05389

Cv=.212H^2/t90

Initial Do 1

Load KSF	Prev. D100	New D100	R in.	t in.	Strain %	Hi in.	Hf in.	H in.	t90 min	Cv in2/min
0.1	0.9					1.1600	1.1600	1.1600		
0.5	0.9000	0.8922	0.0078	0.0078	0.7	1.1600	1.1522	1.1561	7.56	0.0375
1	0.8922	0.8816	0.0106	0.0184	1.6	1.1522	1.1416	1.1469	3.8	0.0744
2	0.8816	0.8674	0.0143	0.0326	2.8	1.1416	1.1274	1.1345	10.5	0.0258
4	0.8674	0.8451	0.0223	0.0549	4.7	1.1274	1.1051	1.1162	6.0	0.0440
8	0.8451	0.8199	0.0252	0.0801	6.9	1.1051	1.0799	1.0925	9.0	0.0281
16	0.8199	0.7795	0.0404	0.1205	10.4	1.0799	1.0395	1.0597	25.0	0.0095

PRE CONSOL

		M.C. DRY	
SAMPLE PLUS RING	240.55		
RING	73.35		19.15
SAMPLE	167.2	148.05	12.9%

POST CONSOL

SAMPLE PLUS RING	237.94	221.4	16.54
RING	73.35	73.35	16.54
SAMPLE	164.59	148.05	11.2%

VOLUME = H*PI*R^2 = 5.05 cubic inches
0.0029 cubic feet

Preconsol

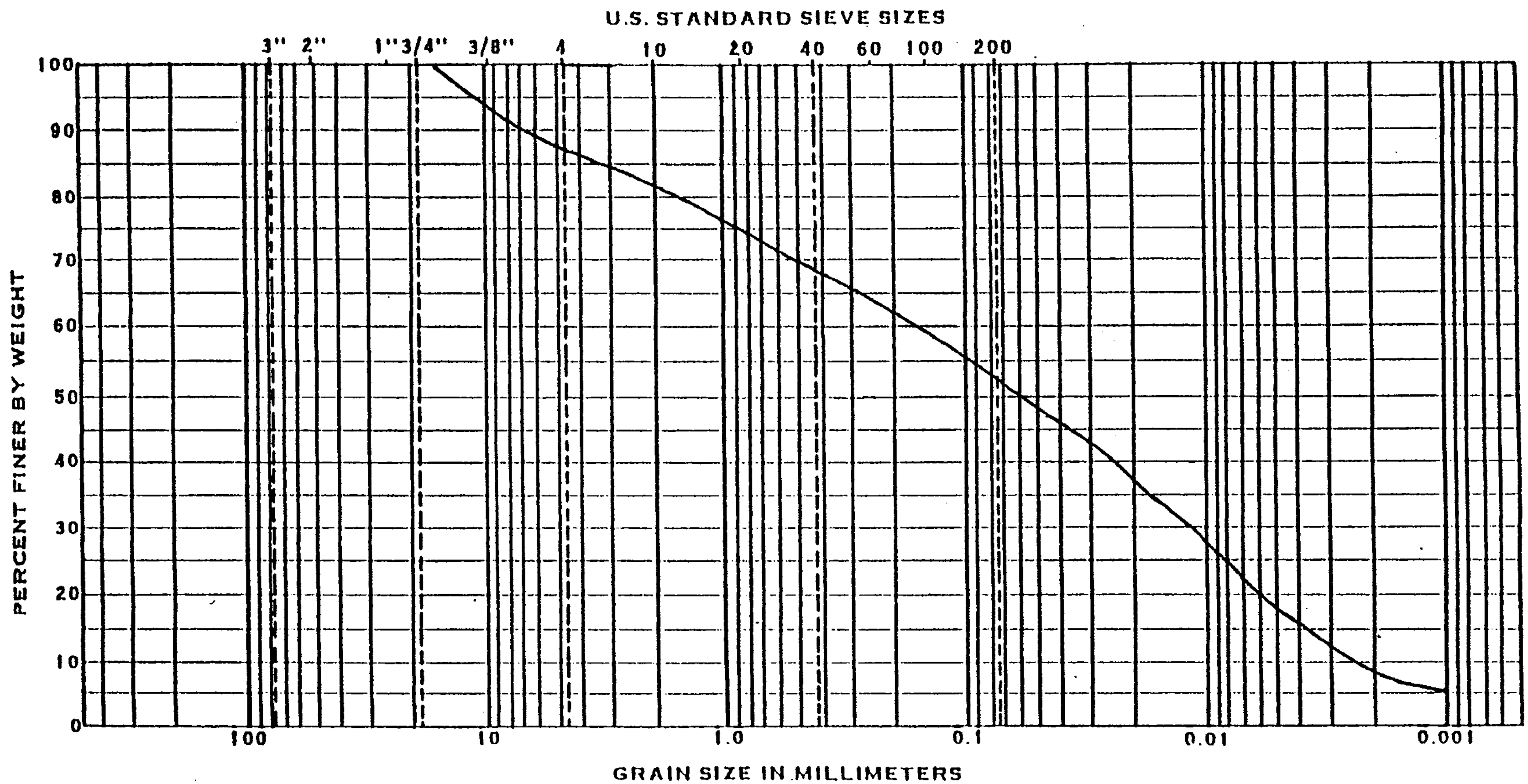
Wet Density	126.06	111.62
Dry Density	111.62	

Postconsol

VOLUME = H*PI*R^2 = 4.73 cubic inches
0.0027 cubic feet

Wet Density	132.35	119.05
Dry Density	119.05	

CGC CHATTAHOOCHEE GEOTECHNICAL CONSULTANTS



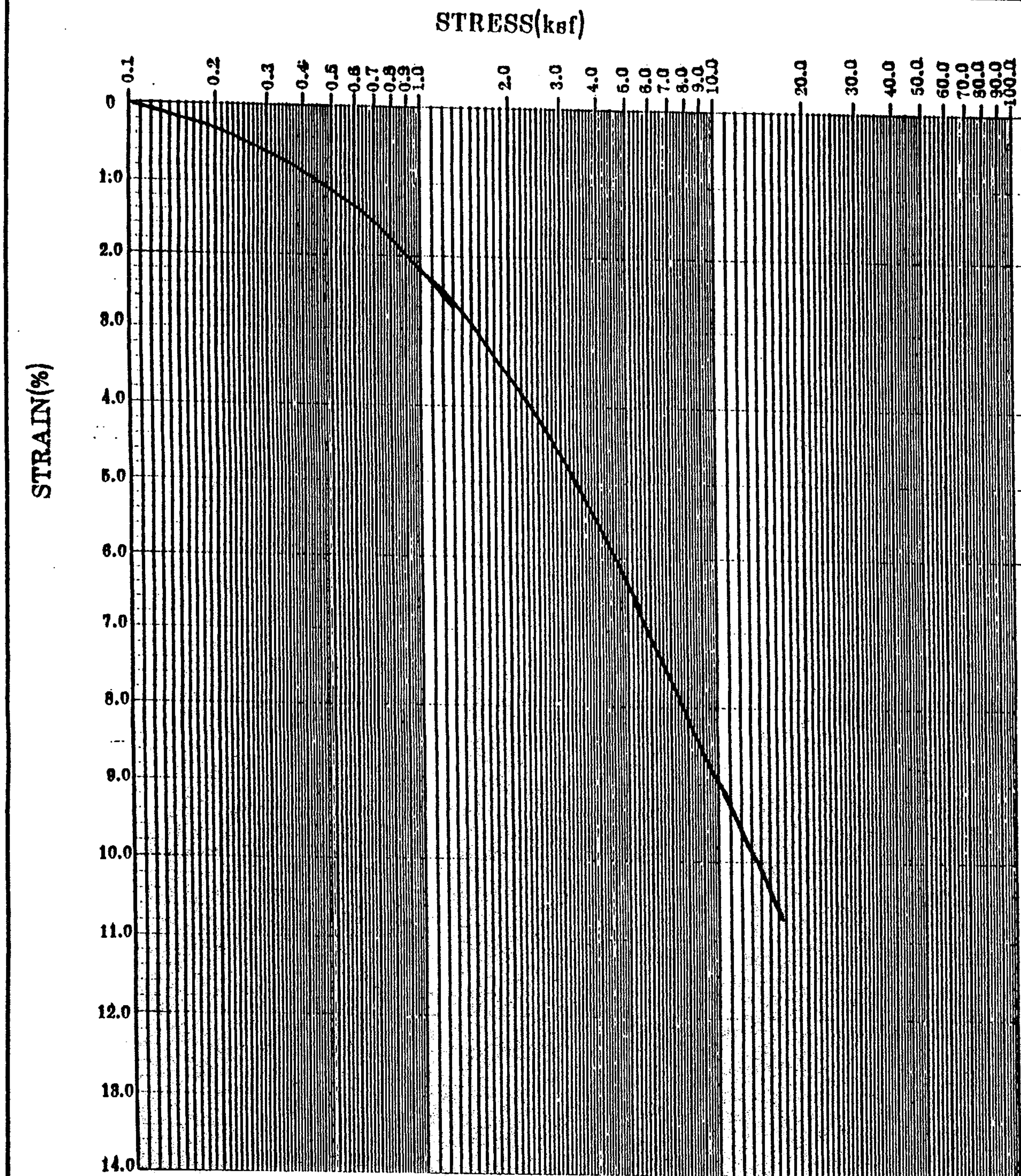
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
P-3	22-22.5	15.9	28	16	12	Sandy SILT, Gray, Some Gravel, Trace Clay. (ML) Back Pressure Saturated Coefficient of Permiability $K=7.4 \times 10^{-4}$ cm/sec

GRAIN SIZE DISTRIBUTION

Project: Ohio National Guard
Project #: 92-233.17
Client: EEI
Date: 6-25-92

CGC CHATTAHOOCHEE GEOTECHNICAL CONSULTANTS



CONSOLIDATION TEST DATA

PROJECT: Ohio National Guard

PROJECT No: 92-233.17 **SAMPLE No:** P3 22'-22

ATTERBERG LIMITS	LL	PL	PI
	28	16	12

	MOISTURE (%)	WET UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pc
INITIAL CONDITIONS	15.9	131.4	113.4
FINAL CONDITIONS	14.0	138.8	121.8

Back Pressure Saturated Coefficient o
Permeability
K= 7.4×10^{-4} cm/sec

Project Name	Ohio National Guard		Date	25-Jun-92
Job Number	92-233.1		Boring	
Sample Number	P-3		Depth	
Height	1.16		Diameter	2.35

m/ci	15.9%	wi	131.4533	di	113.41015
m/cf	14.0%	wf	138.7872	dc	121.78655

Cv=.212H^2/t50

Initial Dc 1

Load KSF	Prev. D100	New D100	R in.	t in.	Strain %	H1 in.	H2 in.	H in.	t50 min	Cv in2/min
0.1	0.9					1.1600	1.1600	1.1600		
0.5	0.9000	0.8884	0.0116	0.0116	1.0	1.1600	1.1484	1.1542	7.3	0.0387
1	0.8884	0.8766	0.0118	0.0234	2.0	1.1484	1.1366	1.1425	6.3	0.0443
2	0.8766	0.8587	0.0179	0.0413	3.6	1.1366	1.1187	1.1277	4.4	0.0618
4	0.8587	0.8335	0.0252	0.0665	5.7	1.1187	1.0935	1.1061	6.3	0.0415
8	0.8335	0.8037	0.0298	0.0963	8.3	1.0935	1.0637	1.0786	16.8	0.0147
16	0.8037	0.7763	0.0275	0.1237	10.7	1.0637	1.0363	1.0500	11.6	0.0202

PRE CONSOL

		M.C. DRY	
SAMPLE PLUS RING	246.9		
RING	73.36		23.82
SAMPLE	173.54	149.72	15.9%

POST CONSOL

SAMPLE PLUS RING	243.98	223.08	20.9
RING	73.36	73.36	20.9
SAMPLE	170.62	149.72	14.0%

VOLUME = H*PI*R^2 = 5.02 cubic inches
0.0029 cubic feet

Preconsol

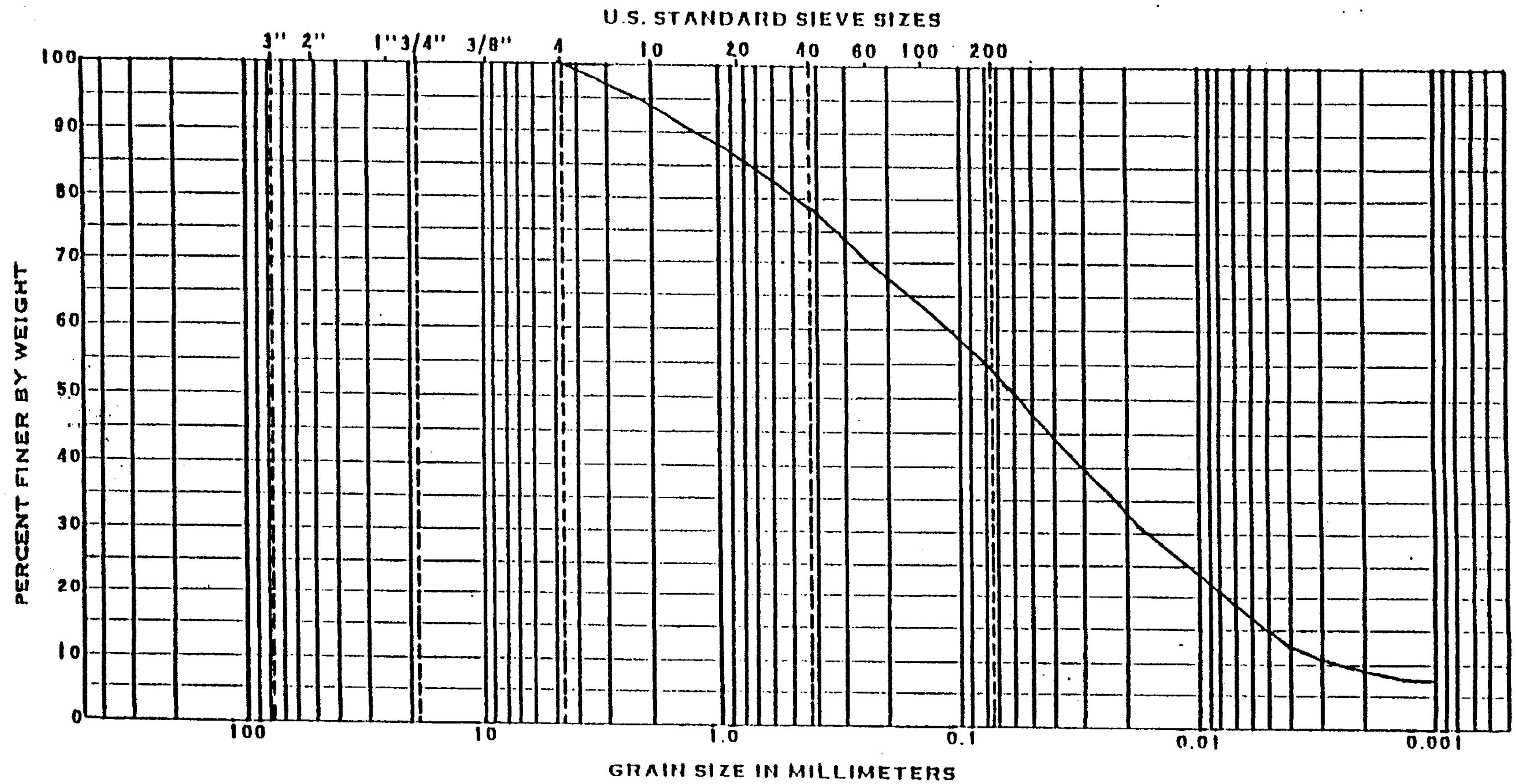
Wet Density	131.45	113.41
Dry Density	113.41	

Postconsol

VOLUME = H*PI*R^2 = 4.68 cubic inches
0.0027 cubic feet

Wet Density	138.79	121.79
Dry Density	121.79	

CGC CHATTAHOOCHEE GEOTECHNICAL CONSULTANTS



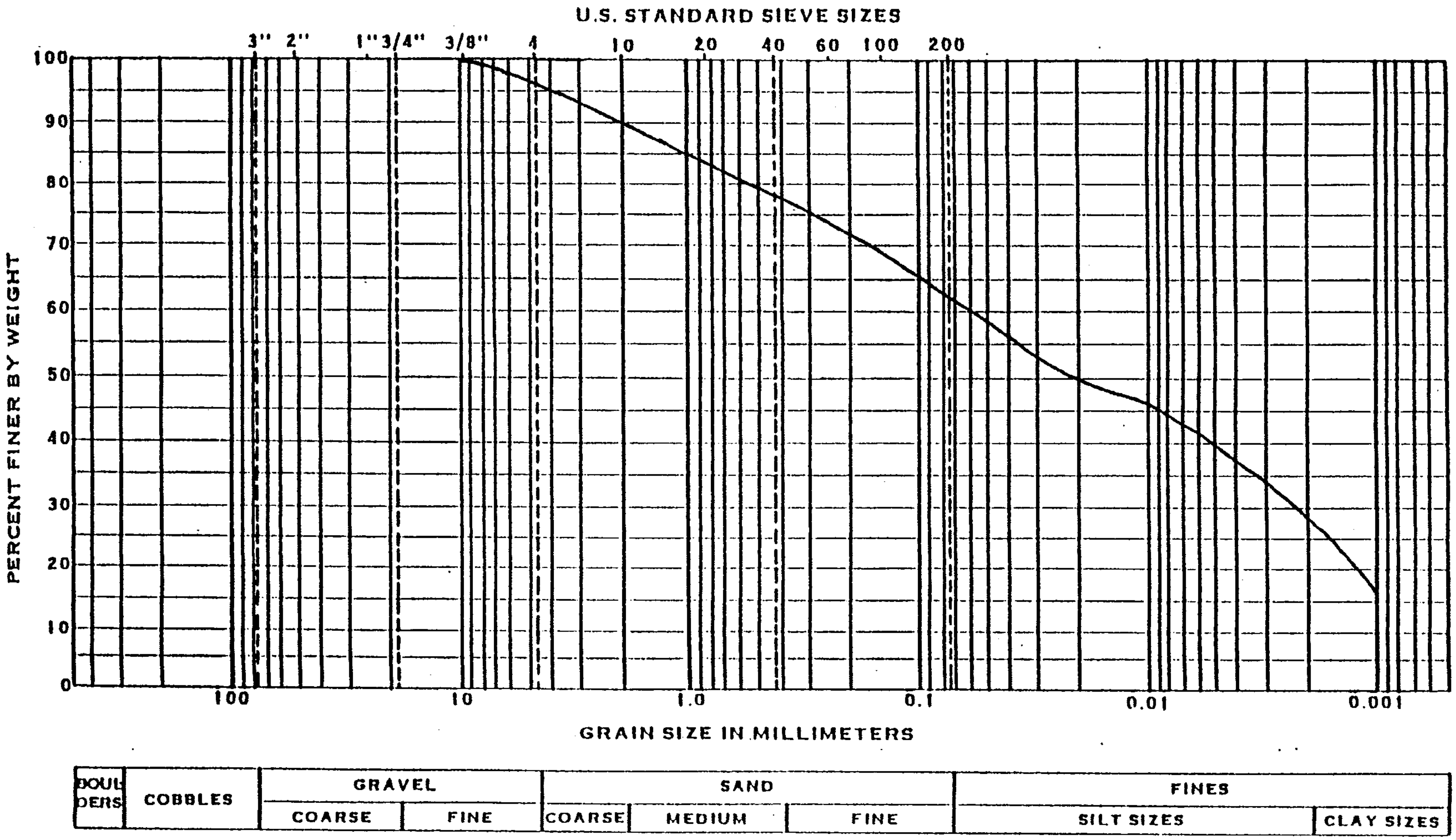
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
P3-6	25-27	58.6	22	13	9	Sandy SILT, Gray, Trace Clay. (SC-CL)

GRAIN SIZE DISTRIBUTIO

Project: Ohio National Guard
Project #: 92-233.17
Client: BBI
Date: 6-29-92

CGC CHATTAHOOCHEE GEOTECHNICAL CONSULTANTS

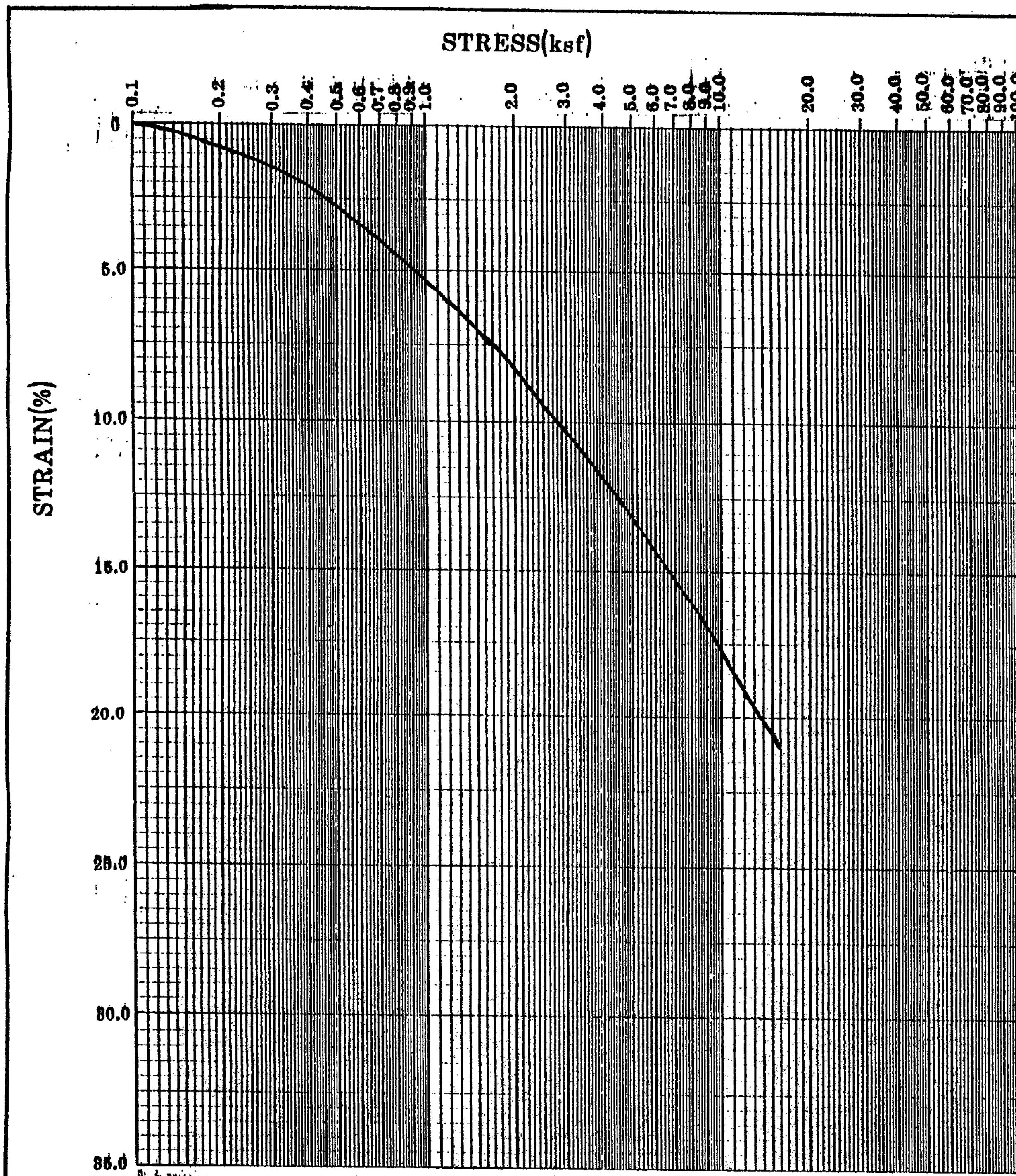


BORING NO.	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
P4-3	10-12	17.6	29	17	12	Silty Clayey SAND, Brown, Trace Gravel (SM,SC) Back Pressure Saturated Coefficient of Permiability K= 7.0 x 10^{-8} cm/sec

GRAIN SIZE DISTRIBUTION

Project: Ohio National Guard
Project #: 92-233.17
Client: EEI
Date: 6-25-92

CGC CHATTAHOOCHEE GEOTECHNICAL CONSULTANTS



CONSOLIDATION TEST DATA

PROJECT: Ohio National Guard

PROJECT No: 92-233.17 SAMPLE No: P4 10'-12

ATTERBERG LIMITS	LL	PL	PI
	29	17	12

(P4-3)

	MOISTURE (%)	WET UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)
INITIAL CONDITIONS	33.2	119.1	89.1
FINAL CONDITIONS	19.4	124.0	103.3

Back Pressure Saturated Coefficient of Permeability
K= 7.0 x 10^{-8} cm/sec. (P-4)

Project Name	OHIO NATIONAL GUARD, SPRINGFIELD		Date	26-Jun-92	
Job Number	92-233.17		Boring		
Sample Number	P-4		Depth	10-12	
Height		1.16	Diameter	2.37	

m/ci	33.1%	wi	118.5948	di	89.070543
m/cf	19.4%	wf	123.3289	dc	103.26798

Cv=.212H^2/t90

Initial Do 1

Load KSF	Prev. D100	New D100	R in.	t in.	Strain %	Hi in.	Hf in.	H in.	t90 min	Cv in2/min
0.1	1					1.1600	1.1600	1.1600		
0.5	1.0000	0.9753	0.0247	0.0247	2.1	1.1600	1.1353	1.1477	36	0.0078
1	0.9753	0.9313	0.0440	0.0687	5.9	1.1353	1.0913	1.1133	90.3	0.0029
2	0.9313	0.9162	0.0151	0.0838	7.2	1.0913	1.0762	1.0837	1.6	0.1586
4	0.9162	0.8429	0.0733	0.1571	13.5	1.0762	1.0029	1.0395	68.1	0.0034
8	0.8429	0.8019	0.0410	0.1981	17.1	1.0029	0.9619	0.9824	31.4	0.0065
16	0.8019	0.7562	0.0457	0.2438	21.0	0.9619	0.9162	0.9391	33.6	0.0056

PRE CONSOL		M.C. DRY		
SAMPLE PLUS RING	230.65			
RING	73.35		39.16	
SAMPLE	157.3	118.14	33.1%	

POST CONSOL

SAMPLE PLUS RING	214.44	191.49	22.95
RING	73.35	73.35	22.95
SAMPLE	141.09	118.14	19.4%

VOLUME = H*PI*R^2 = 5.05 cubic inches
0.0029 cubic feet

Preconsol

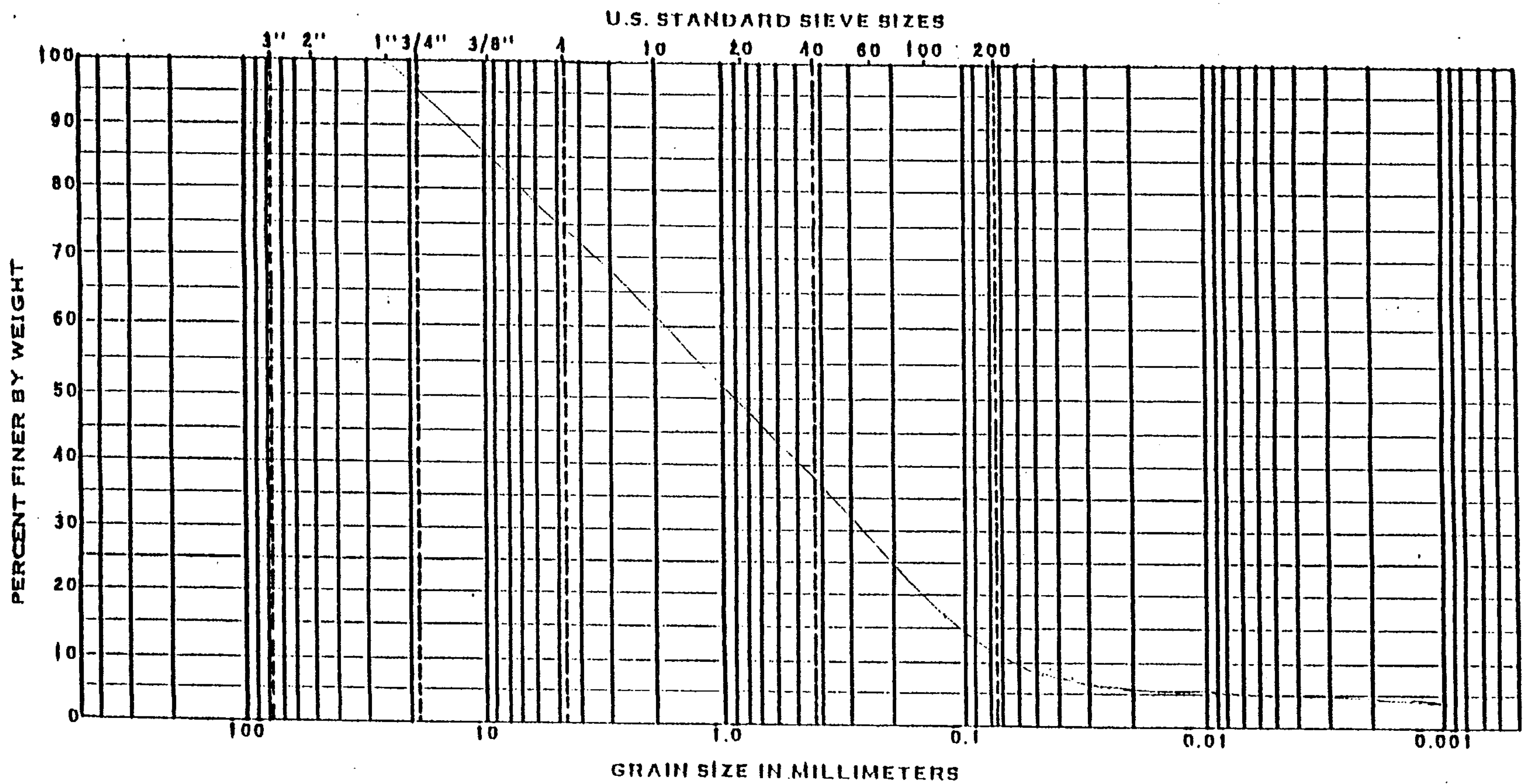
Wet Density	118.59	89.07
Dry Density	89.07	

Postconsol

VOLUME = H*PI*R^2 = 4.35 cubic inches
0.0025 cubic feet

Wet Density	123.33	103.27
Dry Density	103.27	

CGC CHATTAHOOCHEE GEOTECHNICAL CONSULTANTS



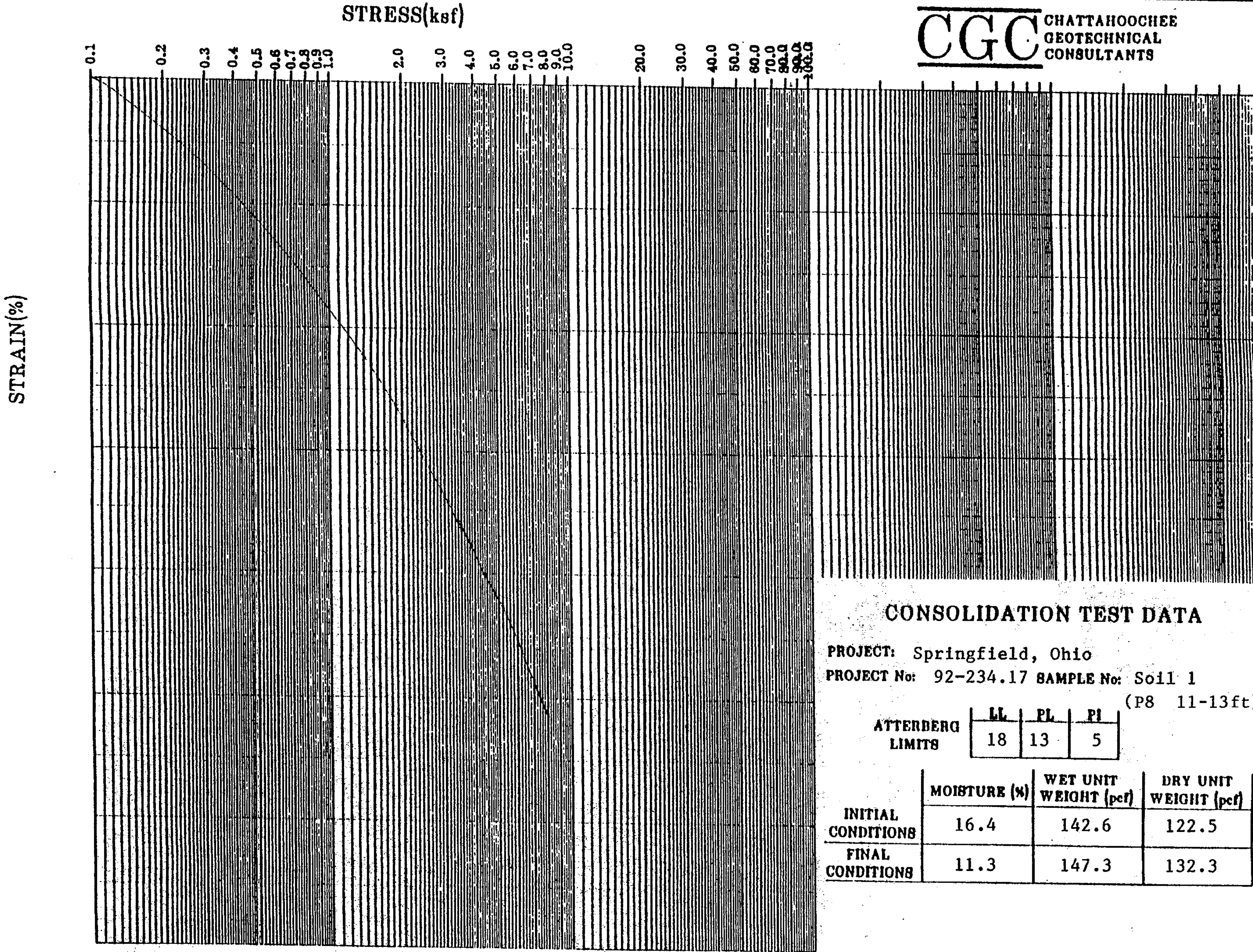
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
Soil 1 P8	-- 11-13 ft	15.0	18	13	5	Gravelly SAND, gray, trace to some clay, (SW-SM) K = 9.9 x 10-8 cm/sec

GRAIN SIZE DISTRIBUTION

Project: Springfield, Ohio
Project #: 92-234.17
Client EEI
Date: 9-29-92

CGC CHATTAHOOCHEE GEOTECHNICAL CONSULTANTS



CONSOLIDATION TEST DATA

PROJECT: Springfield, Ohio

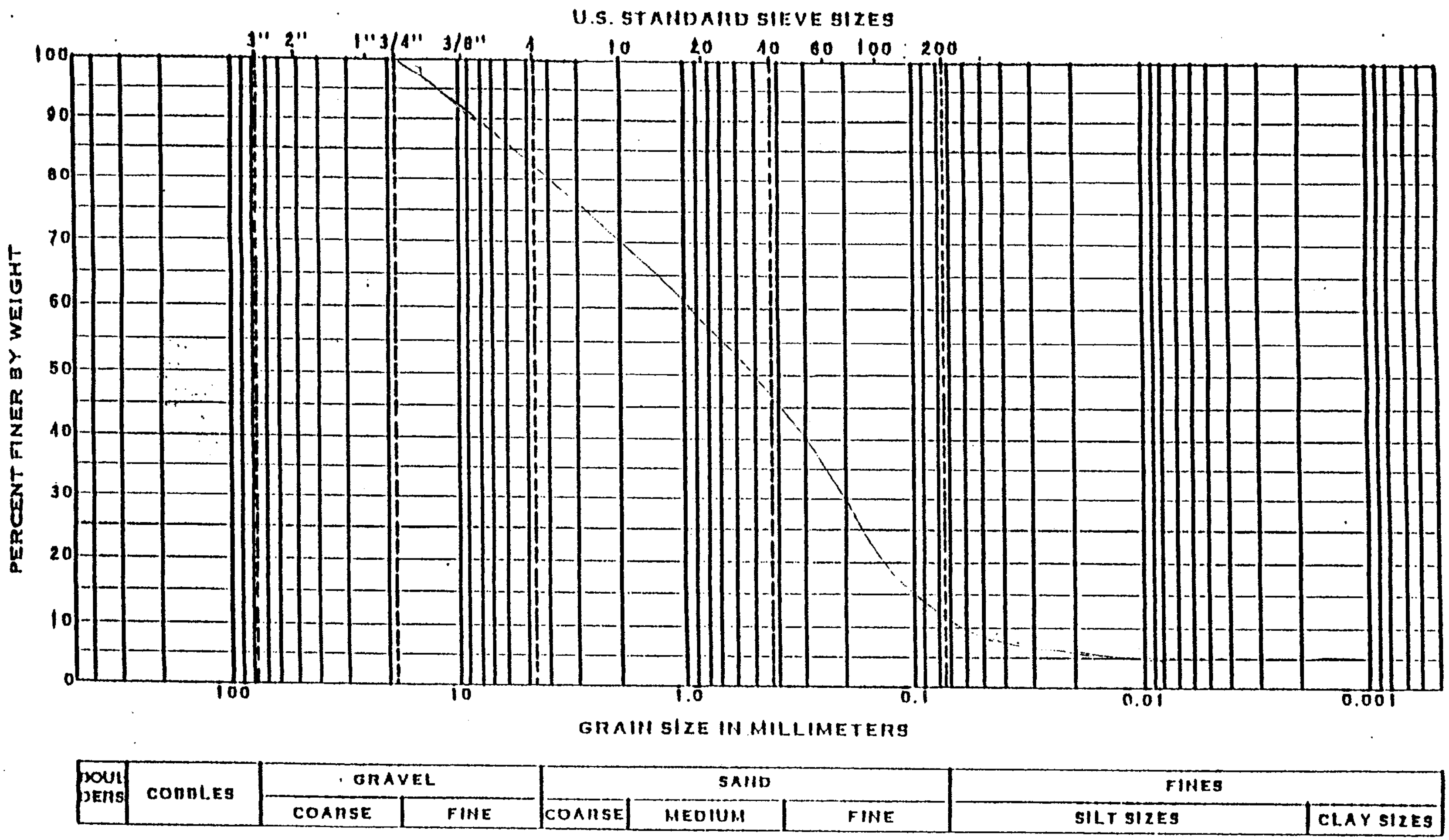
PROJECT No: 92-234.17 **SAMPLE No:** Soil 1 (P8 11-13ft)

ATTERBERG LIMITS

LL	PL	PI
18	13	5

	MOISTURE (%)	WET UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)
INITIAL CONDITIONS	16.4	142.6	122.5
FINAL CONDITIONS	11.3	147.3	132.3

CGC CHATTAHOOCHEE GEOTECHNICAL CONSULTANTS

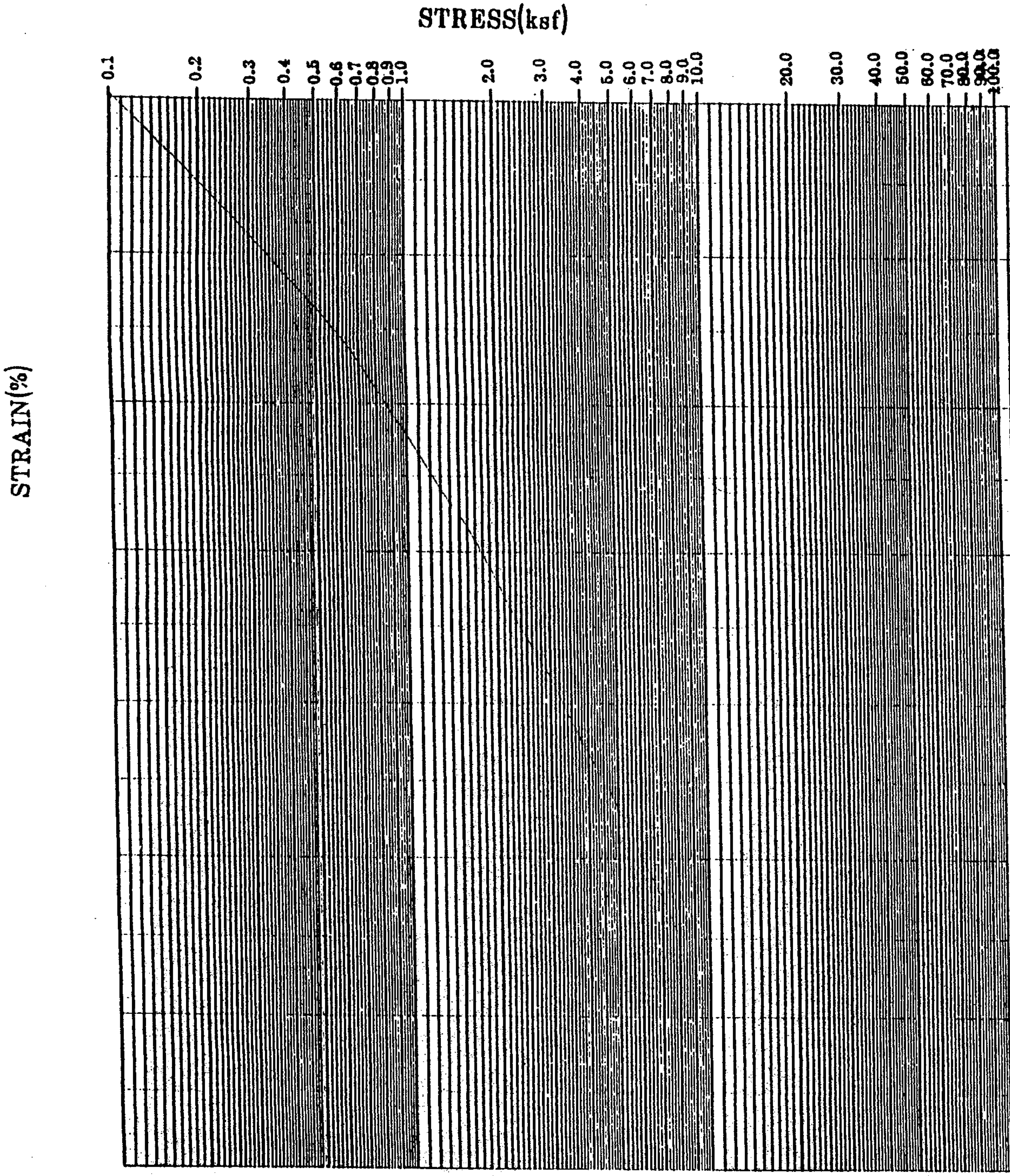


BORING NO.	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
Soil 2 MW3-1	-- 16-18 ft	36.6	35	20	15	Gravelly SAND, gray, trace to some clay, (SP-SM) K = 2.4 x 10-8 cm/sec

GRAIN SIZE DISTRIBUTION

Project: Springfield, Ohio
Project #: 92-234.17
Client EEI
Date: 9-29-92

CGC CHATTAHOOCHEE GEOTECHNICAL CONSULTANTS



CONSOLIDATION TEST DATA

PROJECT: Springfield, Ohio

PROJECT No: 92-234.17 **SAMPLE No:** Soil 2 (MW3-1 16-18)

ATTERBERG LIMITS	LL	PL	PI
	35	20	15

	MOISTURE (%)	WET UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)
INITIAL CONDITIONS	40.9	114.6	81.4
FINAL CONDITIONS	30.8	123.92	94.77

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APPENDIX K

Field Forms - Chain-of-Custody, Sampling, Water Level, and Well Development Forms

Chain-of-Custody Forms

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Chain of Cu ody Record

Date 5-6-92 Page 1 of 1

Shipment N 01

Name Tom Weatherly
Address 1710 Goodridge Dr T24-1 McLean 22102
Phone Number 703 734 5584
Project Manager Al Wicklund
Project Name Springfield-OANG Site Inspection
Job/P.O. No. 1-827-03-200-02
Sampler (Signature) Tom Weatherly (Printed Name)

Requested Parameters:
A VOA-S 180
B VOA W (8240) 180
C Fuel-Diesel 110
E BNA-S 320
D MET-PP 175
F BNA-W 320

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	TPH CA Modified 8015	VOC SW 8240	SVOC SW 3550/8270	Priority Pollutant Metals							No. of Containers
	Soil	SDS-1	5-6-92	1420	Site 5	✓	✓	✓	✓	A		C	D	E		1
	Soil	SDS-2	5-6-92	1405	Site 5	✓	✓	✓	✓							1
	Soil	SDS-3	5-6-92	1355	Site 5	✓	✓	✓	✓							1
	Soil	SDS-4	5-6-92	1350	Site 5	✓	✓	✓	✓							1
	Soil	SDS-5	5-6-92	1435	Site 5	✓	✓	✓	✓							1
	Water	SDS-ER	5-6-92	1450	Site 5	✓	✓	✓	✓		B					3
	Water	SDS-FB	5-6-92	1450	Site 5	✓	✓	✓	✓						F	3
	TB	Springfield TB	5-6-92	1450	Site 5		✓									2
	Soil	SDS-3R	5-6-92	1355	Site 5	✓	✓	✓	✓	A		C	D	E		1

* looking for diesel per Al Wickline 5/7/92 BC

Total containers 14

Observations, Comments, Special Instructions

Preserve Metals & VOA waters in Lab

soil jar

2-1L glass, small jar

2 VOA's

soil jar

AIRBILL # 3912742525

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser Way S. Federal Way WA. 98003
Phone 2069246242
Contact Name Bonnie Chappel

Relinquished by	Date	Received by	Date
Signature [signature]	5/6/92	Signature Bonnie Chappel	5/7/92
Printed Name Tom Weatherly	Time 1900	Printed Name BONNIE CHAPPEL	Time 1010
Company SAIC		Company Weyco	
Relinquished by	Date	Received by	Date
Signature		Signature	
Printed Name	Time	Printed Name	Time
Company		Company	

Total Number of Containers:

Instructions
1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method:

SAIC Location (circle)
Washington, D.C. 1710 Goodridge Dr., McLean, VA 22102 (703) 734-2500
Oak Ridge 800 Oak Ridge Tnpk., Oak Ridge, TN 37830 (615) 482-9031
Paramus One Sears Drive, Paramus, NJ 07652 (201) 599-0100
Denver 1626 Cole Boulevard, Suite 270, Golden, CO 80401 (303) 231-9094
Seattle 13400B Northup Way, S36, Bellevue, WA 98005 (206) 747-7890
San Diego 4224 Campus Point, Building 3, San Diego, CA 92121 (619) 535-7436

Science Applications International Corporation

White Laboratory Pink Project Manager Yellow Project QAO Goldenrod Field Project Manager

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Date 5-7-92 Page 1 of 1

Shipment No. 02

Name TOM WEATHERLY
Address SEE SAIC LOC. BELOW
Phone Number 703 734 5584
Project Manager AL WICKLINE
Project Name BLUE ASH DANC SI
Job/P.O. No. 1-827-03-200-02
Sampler (Signature) [signature] (Printed Name) TOM WEATHERLY

Laboratory Name WEYERHAEUSER
Address 32901 WEYERHAEUSER WAY S. FED. WAY, WA 98003
Phone 206 924 6293
Contact Name BONNIE CHAPPEL

Laboratory No	Matrix	Sample No.	Date	Time	Site/Zone	TPH 8015	SVOL 8270	VOC 8240	P.P. METALS		No. of Containers	Observations, Comments, Special Instructions
	SOIL	B2-1-1	5-7-92	1730	SITE 2	✓	✓	✓	✓	A	1	PEOX
	"	B2-1-2	5-7-92	1820	"	✓	✓	✓	✓		1	AIRBILL —
	"	B2-2-1	5-7-92	1130	"	✓	✓	✓	✓		1	3912742536
	"	B2-2-2	5-7-92	1145	"	✓	✓	✓	✓		1	
	"	B2-3-1	5-7-92	1640	"	✓	✓	✓	✓		1	
	"	B2-3-2	5-7-92	1705	"	✓	✓	✓	✓		1	
	"	B2-4-1	5-7-92	1015	"	✓	✓	✓	✓		1	
	"	B2-4-2	5-7-92	1045	"	✓	✓	✓	✓		1	
	AQ	BA-TB-1			"			✓		1	2	
										TOTAL	10	

Relinquished by	Date	Received by	Date
Signature: [signature]	5-7-92	Signature:	
Printed Name: TOM WEATHERLY	Time: 2030	Printed Name:	Time:
Company: SAIC		Company:	

Relinquished by	Date	Received by	Date
Signature:		Signature: [signature]	5/8/92
Printed Name:	Time:	Printed Name: Bobbie Foster	Time: 1030
Company:		Company: Weyerhauser	

Total Number of Containers

Instructions

1. Fill out form completely except for shaded areas (lab use only)
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method

SAIC Location (Circle)

Washington, D.C.
1710 Goodridge Dr., McLean, VA 22102
(703) 734 2500

Oak Ridge
800 Oak Ridge Tnpk., Oak Ridge, TN 37830
(615) 482-9031

Paramus
One Sears Drive, Paramus, NJ 07652
(201) 599 0100

Denver
1626 Cole Boulevard, Suite 270, Golden, CO 80401
(303) 231 9094

Seattle
13400B Northup Way, S38, Bellevue, WA 98005
(206) 747 7899

San Diego
4224 Campus Point, Building 3, San Diego, CA 92121
(619) 535-7438

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Date 5-11-92 Page 1 of 2

Shipment No. 03

Name: Tom Weatherly
Address: 1710 Goodridge Dr
Phone Number: 703 734 5584
Project Manager: Al Wickline
Project Name: Blue Ash Dang
Job/P.O. No.: 1-827-03-200-02

Sampler (Signature) / (Printed Name): Tom Weatherly

Laboratory Name: Weyerhaeuser
Address: 32901 Weyerhaeuser Way, Fed Way 98003
Phone: 206 924 6242
Contact Name: Bonnie Chappel

Laboratory No.	Matrix	Sample No	Date	Time	Site/Zone	TPH 8015	SVOC 3550/8270	VOC 8240	Pb 7421	P.P. Metals	No. of Containers	Observations, Comments, Special Instructions
	SOIL	B1-1-1	5-10-92	1145		/	/		/		1	FedEx
	"	B1-2-1	5-10-92	1225		/	/		/		1	Airbill # 3912742540
	"	B1-2-2	5-10-92	1250		/	/		/		1	
	"	B1-2-2R	5-10-92	1250		/	/		/		1	
	"	B1-3-2	5-10-92	1220		/	/		/		1	
	"	B1-3-1	5-10-92	1145		/	/		/		1	
	AQ	B1-ER	5-10-92	2000		/	/		/		2	
	SOIL	B1-4-1	5-10-92	1515		/	/		/		1	
												11 TOTAL ON COC
	SOIL	MW-B6-25	5-9-92	1459		/	/	/		/	1	Note sample date 5-9-92!!!
	SOIL	MW-B6-15	5-9-92	1341		/	/	/		/	1	in cooler #2

Relinquished by	Date	Received by	Date
Signature: (signature)	5-11-92	Signature: Bonnie Chappel	5-12-92
Printed Name: Tom Weatherly	Time: 1200	Printed Name: BONNIE CHAPPEL	Time: 1020
Company: SAIC		Company: Weyerhaeuser	

Relinquished by	Date	Received by	Date
Signature		Signature	
Printed Name	Time	Printed Name	Time
Company		Company	

Total Number of Containers:

Instructions

1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method:

SAIC Location (circle)

Washington, D.C.
1710 Goodridge Dr., McLean, VA 22102
(703) 734-2500

Oak Ridge
800 Oak Ridge Tnpk., Oak Ridge, TN 37830
(615) 482-9031

Paramus
One Sears Drive, Paramus, NJ 07652
(201) 599-0100

Denver
1626 Cole Boulevard, Suite 270, Golden, CO 80401
(303) 231-9094

Seattle
13400B Northup Way, S36, Bellevue, WA 98005
(206) 747-7899

San Diego
4224 Campus Point, Building 3, San Diego, CA 92121
(619) 535-7438

Science Ap... ...ons International Corporation — White Laboratory — Pink Project Manager — Yellow Project QAO — Goldenrod ...oject Manager

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Date 5-11-92 Page 2 of 2

Shipment No. 03

Name: TOM WEATHERLY
Address: 1710 GOODRIDGE DR
Phone Number: 203 7345584
Project Manager: See Pg 1
Project Name:
Job/P O No.:
Sampler (Signature) (Printed Name)

Laboratory Name: See Page 1
Address:
Phone:
Contact Name:

Laboratory No	Matrix	Sample No	Date	Time	Site/Zone	TPH 8015	SVOC 3550/8270	VOC 8240	P.P. Metals	Requested Parameters (cont.)	No. of Containers	Observations, Comments, Special Instructions
	AQ	B2-ER		1930		/	/	/	/		3	
	AQ	BA-FB		1900		/	/	/	/		3	
	AQ	B6-ER ~~B1-ER~~		2100		/	/	/	/		3	
	AQ	BA-TB-2		—				/			2	
	SOIL	MW2-2-15		1745		/	/	/	/		1	
	"	B2-6-2R		1717		/	/	/	/		1	
1.	"	B2-2-2		1830		/	/	/	/	TO REPLACE SAMPLE REC'D 7/8	1	
	"	B2-5-1		1540		/	/	/			1	
	"	B2-5-2		1545		/	/	/	/		1	
	"	B2-6-2		1717		/	/	/	/		1	
	"	B2-6-1		1550		/	/	/	/		1	
?	"	B2-1-2		1750		/	/	/	/	TO REPLACE SAMPLE REC'D 9/8	1	19 TOTAL Containers

Relinquished by	Date	Received by	Date
Signature: [signature]	5-11-92	Signature: Bonnie Chappel	5-12-92
Printed Name: TOM WEATHERLY	Time 1200	Printed Name: BONNIE CHAPPEL	Time 1020
Company: SAIC		Company: Weyerhaeuser	

Relinquished by	Date	Received by	Date
Signature		Signature	
Printed Name	Time	Printed Name	Time
Company		Company	

Total Number of Containers:

Instructions
1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method:

SAIC Location (circle)
Washington, D.C. 1710 Goodridge Dr., McLean, VA 22102 (703) 734-2500
Oak Ridge 800 Oak Ridge Tnpk., Oak Ridge, TN 37830 (615) 482 9031
Paramus One Sears Drive, Paramus, NJ 07652 (201) 599-0100
Denver 1626 Cole Boulevard, Suite 270, Golden, CO 80401 (303) 231-9094
Seattle 13400B Northup Way, S36, Bellevue, WA 98005 (206) 747-7899
San Diego 4724 Campus Point, Building 3, San Diego, CA 92121 (619) 535 7438

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FED EX 1031200202

Date 6-2-92 Page 1 of 1

Shipment No. 04

Name Paul Parrish
Address 1321 Research Park Dr. Dayton Oh 45432
Phone Number (513) 429-6648
Project Manager Al Wickline
Project Name Springfield-Beckley/Blue Ash SI
Job/P.O. No. 01-0827-03-0200-003
Sampler (Signature) (Printed Name)

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser Way S. Fed. Way, WA 98003
Phone (206) 924-6293
Contact Name Bonnie Chappel

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	VOC SW5030/8020 HCl pH<2	VHC SW5030/8010	SVOC SW3510/8270	TPH Calif Method 8015 HCl pH<2	*Metals SW3005/6010 HNO3 pH<2	Requested Parameters	Temperature °C	No. of Containers	Observations, Comments, Special Instructions
	Water	MW-BG	6-2-92	1337	Blue Ash	X	X	X	X	X	ABCD		15	
	↓	MW2-1	6-2-92	1209	Blue Ash	X	X	X	X	X			15	
		TB-1	6-2-92	1900	↓	X					D		1	per BMC list as 2 samples 6/3
		TB-2	6-2-92	1900			X				D		1	
	Water	CB-1,2	6-2-92	1900							D		2	4°C 6/3/92
	Water	MW2-2	6-2-92	1305	Blue Ash	X					no test D	X	2	

*Priority Pollutant Metals Include:
Antimony SW 3005/7041
Arsenic SW 7060
Lead SW 3020/7421
Mercury SW 7470
Selenium SW 7740
Thallium SW 3020/7841

Relinquished by	Date	Received by	Date
Signature: [signature] / Printed Name: Paul M. Parrish / Company: SAIC	6/2/92, Time 1900	Signature / Printed Name / Company	Time
Relinquished by: Signature / Printed Name / Company	Date / Time	Received by: Signature: Bonnie Chappel / Printed Name: BONNIE CHAPPEL / Company: Weyerhaeuser	6/3/92, Time 1045

Total Number of Containers:

Instructions
1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method: FED EX

SAIC Location (circle)
Washington, D.C. 1710 Goodridge Dr., McLean, VA 22102 (703) 734-2500
Oak Ridge 800 Oak Ridge Tnpk., Oak Ridge, TN 37830 (615) 482-9031
Paramus One Sears Drive, Paramus, NJ 07652 (201) 599-0100
Denver 1626 Cole Boulevard, Suite 270, Golden, CO 80401 (303) 231-9094
Seattle 13400B Northup Way, S36, Bellevue, WA 98005 (206) 747-7899
San Diego 4224 Campus Point, Building 3, San Diego, CA 92121 (619) 535-7438

Science Applications International Corporation

White: Laboratory Pink: Project Manager Yellow: Project QAO Goldenrod: Field Project Manager

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Date 6-3-92 Page 1 of 1

Shipment No. 05

Name Paul Parrish
Address 1321 Research Park Dr. Dayton OH 45432
Phone Number (513) 429-6648
Project Manager Al Wickline
Project Name Springfield-Beckley/Blue Ash SI
Job/P.O. No. 01-0927-03-0200-003

Sampler (Signature) Paul Parrish (Printed Name) Paul M Parrish

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser Way S. Federal Way, WA 98003
Phone (206) 924-6293
Contact Name Bonnie Chappel

Laboratory No	Matrix	Sample No.	Date	Time	Site/Zone	VAC SW5030/8020 HCl pH<2	VHC SW5030/8010	SVOC SW 3510/8270	TPH Calif Method 8015 HCl pH<2	Metals SW 3005/6010 HNO3 pH<2 *	Temperature °C	No. of Containers	Observations, Comments, Special Instructions
	WATER	MW/2-1D	6-3-92	1255	Blue Ash	X	X	X	X	X		13	unable to get 1 SVOC & 1 TPH
	↓	MS/MSD	6-3-92	1335	Blue Ash	4	4	3	3	1		15	Sample from MW-BG (?) see phone log
		EB-1	6-3-92	1150		4	4	3	3	1		15	
		FB-1	6-3-92	1220		4	4	3	3	1		15	
		TB-1	6-3-92	1700		1		only rec'd 1 TB-				1	
	↓	TB-2	6-3-92	1700	↓		1	it was marked TB-3				1	
*	WATER	CB-3,4	6-3-92	1700	Blue Ash	→ rec'd 3 coolant blanks					X	2	*Priority Pollutant Metals include:
						(1 says coolant blank only 2 say 3+4 as noted)							Antimony SW 3005/7041
													Arsenic SW 7060
→ Coolant Blank temp 13.2°C upon arrival													Lead SW 3020/7421
at Weyerhaeuser SMO - all ice was melted													Mercury SW 7470
													Selenium SW 7740
		Called Paul Parrish	w/ above info. 6/4										Thallium SW 3020/7841

Total Number of Containers:

Shipment Method: Fed Ex

Relinquished by	Date	Time	Received by	Date	Time
Signature: Paul Parrish; Printed Name: Paul M Parrish; Company: SAIC	6/3/92	1900	Signature: Diana L. Schafer; Printed Name: DIANA L. Schafer; Company: Weyco SMO	6/4/92	1215
Signature: ; Printed Name: ; Company:			Signature: ; Printed Name: ; Company:		

Instructions
1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

SAIC Location (circle)
Washington, D.C. 1710 Goodridge Dr., McLean, VA 22102 (703) 734-2500
Oak Ridge 800 Oak Ridge Tpke., Oak Ridge, TN 37830 (615) 482-9031
Paramus One Sears Drive, Paramus, NJ 07652 (201) 599-0100
Denver 1626 Cole Boulevard, Suite 270, Golden, CO 80401 (303) 231-9094
Seattle 13400B Northup Way, S36, Bellevue, WA 98005 (206) 747-7869
San Diego 4224 Campus Point, Building 3, San Diego, CA 92121 (619) 535-7438

Science Applications International Corporation

White: Laboratory Pink: Project Manager Yellow: Project QAO Goldenrod: Field Project Manager

Air Bill No. 5112142575

Shipment No. 1

SAIC Science Applications International Corporation
An Employee-Owned Company

Chain of Cu. ly Record

Date 8/13/92 Page 1 of 2

Name Tom Weatherly
Address 1710 Goodridge Dr. McLean, Va. 22102
Phone Number (703) 734-2500
Project Manager A. Wickline
Project Name Springfield/Blue Ash OMIG SI
Job/P.O. No. 01-0827-03-0200-003
Sampler (Signature) (Printed Name) Tom Weatherly

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser Way S Federal Way, Wa 98003
Phone (206) 924-6293
Contact Name Bonnie Chappel

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	TPH 8015	VOC 8240	PP Metals 6010	SVOC 8270	Sb 7041	As 7060	Pb 7421	Hg 7471	Se 7740	Thallium 7487				No. of Containers	Observations, Comments, Special Instructions
✓✓✓	Soil	SB1-2-B	8-13	1709	Site 1/FTA1	X	X	X	X	X	X	X	X	X	X				3 ✓	
✓✓✓	Soil	SB1-1-1	8-13	1023	Site 1/FTA1	X	X	X	X	X	X	X	X	X	X				3 ✓	Some Samples
	Soil	SB1-2-1	8-13	1540	Site 1/FTA1	X	X	X	X	X	X	X	X	X	X				3 ✓	Collected 8-12!!
✓	Soil	MWBG1-2	8-12	1724	MWBG1		X		X										2 ✓	
	Soil	~~SB1-1-3~~	~~8-13~~	~~1056~~	~~FTA1~~			X	X	X	X	X	X	X	X				2	Sample Not Sent
✓✓	Soil	MWBG1-1	8-12	1707 (*)	MWBG1	X	X	X	X	✓	✓	✓	✓	✓	✓				3 ✓	
✓	Soil	SB4-1-2	8-12	0804	POL Yard	X	X	X				X							3	
✓✓	Soil	SB4-2-1	8-12	1027	POL Yard	X	X	X				X							3	no met-PP sleeve rec'd
✓✓	Soil	SB4-1-1	8-12	0753	POL Yard	X	X	X				X							3	only 2 sleeves rec'd
✓✓	Soil	SB4-2-2	8-12	1036	POL Yard	X	X	X				X							3	
✓✓✓	Soil	SB1-1-6	8-13	1441	FTA1	X	X	X	X	X	X	X	X	X	X				3 ✓	(*) time on sample = 1730
✓	Water	TB-1					X													
✓	Water	TB-2					X													

Total Number of Containers: 31 ~~30~~ ~~32~~

Shipment Method: Fed Ex

Relinquished by	Date	Received by	Date
Signature: [signature]	8/13/92	Signature	
Printed Name: Tom Weatherly	Time 2000	Printed Name	Time
Company: SAIC		Company	

Relinquished by	Date	Received by	Date
Signature		Signature: Bonnie Chappel	8/14/92
Printed Name	Time	Printed Name: BONNIE CHAPPEL	Time 1020
Company		Company: Weyerhaeuser	

C0059

Instructions

1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

SAIC Location (circle)
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Paramus One Sears Drive, Paramus, NJ 07652 (201) 599-0100
Denver 1826 Cole Boulevard, Suite 270, Golden, CO 80401 (303) 231-9094
Seattle 13400B Northup Way, B36, Bellevue, WA 98005 (206) 747-7860
San Diego 4224 Campus Point, Building 3, San Diego, CA 92121 (619) 535-7436

White: Laboratory Pink: Project Manager Yellow: Project QAO Goldenrod: Field Project Manager

Science Applications International Corporation

Air Bill No [illegible]

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Chain of Cu[...]dy Record

Date 8/13/92 Page 2 of 2

Shipment No 1

Name Tom Weatherly
Address 1710 Goodridge Dr. McLean, VA 22102
Phone Number (703) 734-2500
Project Manager Al Wickline
Project Name Springfield/Blue Ash ONG SI
Job/P.O. No. 01-0827-03-0200-003

Sampler (Signature) [signature] (Printed Name) Tom Weatherly

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser Way S Federal Way, WA 98003
Phone (206) 924-6293
Contact Name Bonnie Chappel

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	TPH 8015	VOC 8240	PP Metals 6010	SVOC 8270	Sb 7041	As 7060	Pb 7421	Hg 7471	Se 7740	Thallium 7487	Temperature			No. of Containers	Observations, Comments, Special Instructions
[illegible]	Soil	SB4-3-1	8-12	1352	POL YARD	X	X	X				X							3	
[illegible]	Soil	SB4-3-1R	8-12	1352	POL YARD	X	X	X				X							3	Some Samples
[illegible]	Soil	SB4-3-3	8-12	1424	POL YARD	X	X	X				X							3	Collected 8-12 !!
[illegible]	Soil	SB4-3-2	8-12	1359	POL YARD	✓	✓	X				X							1	*
[illegible]	Water	CB-1,2														X			2	* If enough pls run VOA + TPH ✓
																				per Tom W. 8/17 BC
																				Total Containers 13 rec'd

Relinquished by	Date	Received by	Date
Signature [signature] Printed Name Tom Weatherly Company SAIC	8/13/92 Time 2000	Signature Printed Name Company	Time
Signature Printed Name Company	Time	Signature Bonnie Chappel Printed Name BONNIE CHAPPEL Company Weyco	8/14/92 Time 1020

Total Number of Containers: 12

Instructions

1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method: Fed Ex

SAIC Location (circle)

Washington, D.C.
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(703) 734-2500

Oak Ridge
800 Oak Ridge Tnpk., Oak Ridge, TN 37830
(615) 482-9031

Paramus
One Sears Drive, Paramus, NJ 07652
(201) 599-0100

Denver
1626 Cole Boulevard, Suite 270, Golden, CO 80401
(303) 231-9094

Seattle
13400B Northup Way, #36, Bellevue, WA 98005
(206) 747-7880

San Diego
4224 Campus Point, Building 3, San Diego, CA 92121
(619) 535-7438

Science Applications International Corporation

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Chain of C[ust]ody Record

Date 8-14-92 Page 1 of 1

Shipment. 002

Name Tom Weatherly
Address 1710 Goodridge Dr T2-4-1 McLean VA 22102
Phone Number 7037345584
Project Manager Al Wickline
Project Name Springfield SI
Job/P.O. No. 01 0827 03 0200003
Sampler (Signature) Tom Weatherly (Printed Name) Tom Weatherly

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser Wy Federal Way, WA 98003
Phone 206 924 6293
Contact Name Bonnie Chappel

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	TPH 8015	VOC 8240	P.P. Metals 6010	SVOC 8270	Sb 7041	As 7060	Pb 7421	Hg 7471	Se 7740	Thallium 7487	Temperature	No. of Containers	Observations, Comments, Special Instructions
ABCD ✓	Soil	SB1-3-1	8-14-92		Site 1	X	X	X	X	X	X	X	X	X	X		3	Aqueous Metals Samples
✓	Soil	SB1-3-11	8-14-92		Site 1	X	X	X	X	X	X	X	X	X	X		3	Preserved w/ Nitric Acid
✓	Soil	SB1-3-11R	8-14-92		Site 1	X	X	X	X	X	X	X	X	X	X		3	
EV ✓	AQ	TB-3					X										~~2~~ 1	
EF	AQ	ER1-1	8.14.92		Site 1	X	X	X	X	X	X	X	X	X	X		5	
✓	AQ	FB1-1	8.14.92		Site 1	X	X	X	X	X	X	X	X	X	X		5	
ABCD	Soil	SB1-1-3	8.13.92		Site 1	X	X	X	X	X	X	X	X	X	X		2	collected 8.13.92 !!!
✓	Soil	SB1-2-3	8.13.92		Site 1	X	X	X	X	X	X	X	X	X	X		3	
✓	Soil	SB1-3-3	8.14.92		Site 1	X	X	X	X	X	X	X	X	X	X		3	
*	AQ	CB-3														X	1	Coolant Blank (not rec'd)
																		Airbill # 3912742606

Total Number of Containers: 29 total

Relinquished by	Date	Received by	Date
Signature [signature]	8/14/92	Signature	
Printed Name Tom Weatherly	Time	Printed Name	Time
Company SAIC		Company	

Relinquished by	Date	Received by	Date
Signature		Signature Bonnie Chappel	8/17/92
Printed Name	Time	Printed Name Bonnie Chappel	Time 1240
Company		Company Weyerhaeuser	

Instructions

1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method:

SAIC Location (circle)

Washington, D.C.
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Oak Ridge
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(615) 482-9031

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(201) 599-0100

Denver
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(303) 231-9094

Seattle
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(206) 747-7899

San Diego
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Science Applications International Corporation

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Chain of Cu[illegible]dy Record

Date 8-17-92 Page 1 of 2

Shipment No 003

Name Tom Weatherly
Address 1710 Goodridge Dr. McLean VA 22102
Phone Number 703 734-5584
Project Manager Al Wickline
Project Name Springfield/Blue Ash SI
Job/P.O. No. 01-0827-03-0200-003

Sampler (Signature) (Printed Name) Tom Weatherly

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser Way Federal Way, WA 98003
Phone 206 924-6293
Contact Name Bonnie Chappel

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	TPH 8015 (B)	VOC 8240 (D)	P.P. Metals 6010 (A)	SVOC 8270 (C)	Sb 7041 ✓	As 7060 ✓	Pb 7421 ✓	Hg 7471 ✓	Se 7740 ✓	Thalium 7487 ✓	Temperature			No. of Containers	Observations, Comments, Special Instructions
[illegible]	Soil	SB2-2-1	8-16-92	1440	FTA2	X	X	X	X	X	X	X	X	X	X				3	
[illegible]	Soil	SB2-2-1R	8-16-92	1440	FTA2	X	X	X	X	X	X	X	X	X	X				3	Collected 8-16-92
[illegible]	Soil	SB2-2-2	8-16-92	1448	FTA2	X	X	X	X	X	X	X	X	X	X				3	
[illegible]	Soil	SB2-2-17	8-16-92	1756	FTA2	X	X	X	X	X	X	X	X	X	X				3	
[illegible]	Soil	SB2-3-1	8-17-92	0754	FTA2	X	X	X	X	X	X	X	X	X	X				3	
[illegible]	Soil	SB2-3-4	8-17-92	0857	FTA2	X	X	X	X	X	X	X	X	X	X				3	8-17
[illegible]	Soil	SB2-3-16	8-17-92	1047	FTA2	X	X	X	X	X	X	X	X	X	X				3	
[illegible]	Soil	SB2-1-14	8-15-92	1623	FTA2	X	X	X	X	X	X	X	X	X	X				1	Collected 8-15-92
[illegible]	Water	EB2-1	8-16-92	1400	FTA2	X	X	X	X	X	X	X	X	X	X				5	Collected 8-16-92 Metals
[illegible]	Water	FB2-1	8-16-92	1400	FTA2	X	X	X	X	X	X	X	X	X	X				5	Preserved w/ Nitric Acid
[illegible]	Water	TB-4					X												2	
[illegible]	Water	CB-2														X			2	Coolant Blank 5°
						D	E	A	F	✓	✓	.	✓	✓	✓					

Relinquished by
Signature [signature]
Printed Name Tom Weatherly
Company SAIC
Date 8/17/92
Time

Received by [illegible]

Date 5/
Time

Relinquished by
Signature
Printed Name
Company
Date
Time

Received by [illegible]
Printed Name [illegible]
Company
Date 8/18/92
Time 1030

Total Number of Containers: 36

Instructions
1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method: Federal Express

SAIC Location (circle)
Washington, D.C.
1710 Goodridge Dr., McLean, VA 22102
(703) 734-2500

Oak Ridge
800 Oak Ridge Tnpk., Oak Ridge, TN 37830
(615) 482-9031

Paramus
One Sears Drive, Paramus, NJ 07652
(201) 599-0100

Denver
1626 Cole Boulevard, Suite 270, Golden, CO 80401
(303) 231-9094

Seattle
13400B Northup Way, S30, Bellevue, WA 98005
(206) 747-7800

San Diego
4224 Campus Point, Building 3, San Diego, CA 92121
(619) 535-7438

Science Applications International Corporation

White: Laboratory Pink: Project Manager Yellow: Project QAO Goldenrod: Field Project Manager

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Chain of Cu: ty Record

Date 8-17-92 Page 2 of 2

Shipment No. 003

Name Tom Weatherly
Address 1710 Goodridge Dr. McLean VA 22102
Phone Number 703 734-5584
Project Manager Ai Nickline
Project Name Springfield Blue Ash SI
Job/P.O. No. 01-0827-03-3200-003
Sampler (Signature)
(Printed Name) Tom Weatherly

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser Way
Federal Way, WA 98003
Phone 206 924-6293
Contact Name Bonnie Chappel

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	TPH 8015	VOC 8240	PP Metals 6010	SVOC 8270	Sb 7041	As 7060	Pb 7421	Hg 7471	Se 7740	Thallium 7487	Temperature			No. of Containers	Observations, Comments, Special Instructions
X	Soil	SBS-1-1	8-17-92	1426	Site 5	X	X	X	X	X	X	X	X	X	X				3	
X	Soil	SBS-1-7	8-17-92	1543	Site 5	X	X	X	X	X	X	X	X	X	X				3	

Relinquished by
Signature
Tom Weatherly
Printed Name
SAIC
Company
Date 8/17/92
Time

Received by
Signature
Printed Name
Company
Date
Time

Relinquished by
Signature
Printed Name
Company
Date
Time

Received by Bobbie Foster
Signature Bobbie Foster
Printed Name
Weyco
Company
Date 8/18/92
Time 1030

Total Number of Containers: 42

Instructions
1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method: Federal Express

SAIC Location (circle)
Washington, D C
1710 Goodridge Dr., McLean, VA 22102
(703) 734-2500

Oak Ridge
800 Oak Ridge Tnpk., Oak Ridge, TN 37830
(615) 482-9031

Paramus
One Sears Drive, Paramus, NJ 07652
(201) 599-0100

Denver
1696 Cole Boulevard, Suite 970, Golden, CO 80401
(303) 231-9084

Seattle
13400B Northup Way, S36, Bellevue, WA 98005
(206) 747-7899

San Diego
4224 Campus Point, Building 3, San Diego, CA 92121
(619) 535-7438

Science Applications International Corporation

White: Laboratory Pink: Project Manager Yellow: Project QAO Goldenrod: Field Project Manager

AB# 541214 LOPC

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Chain of Cu. .dy Record

Date 8-18-92 Page 1 of 1

Shipment No 004

Name Tom Weatherly
Address 1710 Goodridge Drive McLean Va 22102
Phone Number (703) 734-5584
Project Manager Al Wickline
Project Name Springfield/Blue Ash SI
Job/P.O. No. 01-0827-03-0200-003
Sampler (Signature) (Printed Name)

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser Way
Federal Way, WA 98003
Phone (206) 924-6293
Contact Name Bonnie Chappel

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	TPH 8015	VOC 8240	P.P. Metals 6010	SVOC 8270	Sb 7041	As 7060	Pb 7421	Hg 7471	Se 7740	Thallium 7487	Temperature				No. of Containers	Observations, Comments, Special Instructions
	Soil	SB2-1-1	8-15-92	1114	FTA#2	X	X	X	X	X	X	X	X	X	X					2	Collected 8-15-92
	Soil	SB2-1-4	8-15-92	1142	FTA2	X	X	X	X	X	X	X	X	X	X					3	
	Soil	SBS-2-1	8-18-92	0744	Site 5	X	X	X	X	X	X	X	X	X	X					3	
	Soil	SBS-2-2	8-18-92	0859	Site 5	X	X	X	X	X	X	X	X	X	X					2	
	Soil	SBS-3-1	8-18-92	1112	Site 5	X	X	X	X	X	X	X	X	X	X					1	←Check sample volume!
	Soil	SBS-3-2	8-18-92	1216	Site 5	X	X	X	X	X	X	X	X	X	X					3	
	Soil	SBS-4-1	8-18-92	1540	Site 5	X	X	X	X	X	X	X	X	X	X					3	
	Soil	SBS-4-1R	8-18-92	1540	Site 5	X	X	X	X	X	X	X	X	X	X					3	
	Soil	SBS-4-2	8-18-92	1657	Site 5	X	X	X	X	X	X	X	X	X	X					1	←Check sample volume
	Water	EBS-1	8-18-92	1230	Site 5	X	X	X	X	X	X	X	X	X	X					5	NOT ~~Preserved~~ Preserved w/ Nitric Acid
	Water	FBS-1	8-18-92	1230	Site 5	X	X	X	X	X	X	X	X	X	X					5	NOT Preserved w/ Nitric Acid
	Water	MB-5	8-18-92				X													2	Preserve metals (water) in Lab
	Water	CB-5	8-18-92																	1	Coolant Blank

Relinquished by	Date	Received by	Date
Signature [signature]	8.18.92	Signature	
Printed Name Tom Weatherly	Time 1900	Printed Name	Time
Company SAIC		Company	

Relinquished by	Date	Received by	Date
Signature		Signature [signature]	8/19/92
Printed Name	Time	Printed Name Bobbie Foster	Time 1030
Company		Company Weyco	

Total Number of Containers: 34

Instructions
1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method:

SAIC Location (circle)

Washington, D.C.
1710 Goodridge Dr., McLean, VA 22102
(703) 734-2500

Oak Ridge
800 Oak Ridge Tnpk., Oak Ridge, TN 37830
(615) 482-9031

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(201) 599-0100

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(303) 231-9094

Seattle
13400B Northup Way, S36, Bellevue, WA 98005
(206) 747-7199

San Diego
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(619) 535-7438

Preserved

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Chain of Custody Record

Date 8-19-92 Page 1 of 1

Shipment No 005

Name Tom Weatherly
Address 1710 Goodridge Dr T24-1
Phone Number 703 734 5584
Project Manager Al Wicklins
Project Name Springfield ST
Job/P.O. No. 1-827-03-200-03

Sampler (Signature) (Printed Name)

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser Way Federal Way WA 98003
Phone 206 924 6243
Contact Name Bonnie Chaffel

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	TPH 8015	SVOC 8270	VOC 8240	PP Metals 6010	Sb 7041	As 7060	Pb 7421	Hg 7471	Se 7740	Thallium 7467	Temp			No. of Containers	Observations, Comments, Special Instructions
	SOIL	SB3-1-1	8.19.92	1713	Site 3	X	X	X	X	X	X	X	X	X	X				2	
	SOIL	~~SB~~ MWB6-2-1	8.19.92	0815	BaseGrd	X	X	X	X	X	X	X	X	X	X				2	
	SOIL	MWB6-2-3	8.19.92	0911	"	X	X	X	X	X	X	X	X	X	X				3	
	SOIL	MWB6-2-3R	8.19.92	0911	"	X	X	X	X	X	X	X	X	X	X				3	
	~~SOIL~~	~~MWB6-2~~																		
	AQ	EB3-1	8.19.92	1530	Site 3	X	X	X	X	X	X	X	X	X	X				5	AQ Metals preserved with HNO_3
	AQ	~~EB~~ FB3-1	8.19.92	1530	Site 3	X	X	X	X	X	X	X	X	X	X				5	
	AQ	TB-6						X											2	
	AQ	CB-6														X			1	
																			23	total

Relinquished by	Date	Received by	Date	
Signature: [signature] / Printed Name: Tom Weatherly / Company: SAIC	Date: 8.19.92 / Time: 1900	Signature / Printed Name / Company	Date / Time	Total Number of Containers:
Relinquished by / Signature / Printed Name / Company	Date / Time	Received by / Signature: Bobbie Foster / Printed Name: Bobbie Foster / Company: Weyco	Date: 8/20/92 / Time: 1100	

Instructions
1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method:

SAIC Location (circle)

Washington, D.C.
1710 Goodridge Dr., McLean, VA 22102
(703) 734-2500

Oak Ridge
800 Oak Ridge Tnpk., Oak Ridge, TN 37830
(615) 482-9031

Paramus
One Sears Drive, Paramus, NJ 07652
(201) 599-0100

Denver
1626 Cole Boulevard, Suite 270, Golden, CO 80401
(303) 231-9094

Seattle
13400B Northup Way, S38, Bellevue, WA 98005
(206) 747-7899

San Diego
4224 Campus Point, Building 3, San Diego, CA 92121
(619) 535-7438

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White: Laboratory Pink: Project Manager Yellow: Project QAO Goldenrod: Field Project Manager

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Chain of Custody Record

Date 8-20-92 Page 1 of 1

Shipment I 006

Name Tom Weatherly
Address 1710 Goodridge Dr
Phone Number 703 734 5584
Project Manager Al Wickline
Project Name Springfield SI
Job/P.O. No. 1-827-03-200-03

Sampler (Signature) (Printed Name) Tom Weatherly

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser Way Rd. Way, WA 98003
Phone 206 924 6293
Contact Name Bonnie Chappel

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	TPH 8015	SVOC 8270	VOC 8240	PP Metals 6010	Sb 7041	As 7060	Pb 7421	Hg 7471	Se 7740	Thallium 7487	Temp			No. of Containers	Observations, Comments, Special Instructions
	Soil	SB3-1-8	8-20-92	0737	Site 3	X	X	X	X	X	X	X	X	X	X				~~12~~	
	Soil	SB3-2-1	8-20-92	0944	Site 3	X	X	X	X	X	X	X	X	X	X				2	Please ensure sufficient sample volume.
	Soil	SB3-2-4	8-20-92	1000	Site 3	X	X	X	X	X	X	X	X	X	X				1	
	Soil	SB3-2-7	8-20-92	1117	Site 3	X	X	X	X	X	X	X	X	X	X				1	
	Soil	SB3-3-1	8-20-92	1158	Site 3	X	X	X	X	X	X	X	X	X	X				1	
	Soil	SB3-3-8	8-20-92	1419	Site 3	X	X	X	X	X	X	X	X	X	X				2	
	~~AQ~~	~~TB-6~~																		
	AQ	TB-7						X								~~X~~			2	
	AQ	CB-7														X			1	2.8

Relinquished by	Date	Received by	Date
Signature: [signature]	8-20-92	Signature	
Printed Name: Tom Weatherly	Time 1900	Printed Name	Time
Company: SAIC		Company	

Relinquished by	Date	Received by	Date
Signature		Signature: Bobbie Foster	8/21/92
Printed Name	Time	Printed Name: Bobbie Foster	Time 1000
Company		Company: Weyco	

Total Number of Containers:

Instructions

1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method:

SAIC Location (circle)

Washington, D.C.
1710 Goodridge Dr., McLean, VA 22102
(703) 734-2500

Oak Ridge
800 Oak Ridge Tnpk., Oak Ridge, TN 37830
(615) 482-9031

Paramus
One Sears Drive, Paramus, NJ 07652
(201) 599-0100

Denver
1626 Cole Boulevard, Suite 270, Golden, CO 80401
(303) 231-9094

Seattle
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(206) 747-7899

San Diego
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(619) 535-7438

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Date 8-21-92 Page 1 of 1

Shipment 007

Name Tom Weatherly
Address 1710 Goodridge Dr. McLean Va
Phone Number (703) 734-5584
Project Manager Al Wickline
Project Name Springfield ST
Job/P.O. No. 1-827-03-200-03

Sampler (Signature) John D. Pendleton (Printed Name) John Pendleton

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser
Federal Way, WA 98003
Phone (206) 924-6293
Contact Name Bonnie Chappel

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	TPH 8015	SVOC 8270	VOC 8240	P.P. Metals 6010	Sb 7041	As 7060	Pb 7421	Hg 7471	Se 7740	Thallium 7487	Temp	No. of Containers	Observations, Comments, Special Instructions
*	Soil	MW3-3-1	8-21-92	0809	Site 3	X	X	X	X	X	X	X	X	X	X		1	Please assure
	Soil	MW3-1-8	8-21-92	1040	Site 3	X	X	X	X	X	X	X	X	X	X		1	sufficient sample
	AQ	TB-8						X									2	volumes
	AQ	CB-8														X	1	

Sample MW3-3-1 is labeled mw3-1-1 on bottle. Which is correct?

Call from Tom Weatherly 8/24 confirmed sample #3-1-1

Relinquished by	Date	Received by	Date
Signature: John D. Pendleton	8/21/92	Signature:	
Printed Name: John D. Pendleton	Time: 1900	Printed Name:	Time:
Company: SAIC		Company:	
Relinquished by	Date	Received by	Date
Signature:		Signature: Bobbie Foster	8/22/92
Printed Name:	Time:	Printed Name: Bobbie Foster	Time: 1030
Company:		Company: Weyco	

Total Number of Containers:

Instructions

1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method:

SAIC Location (circle)

Washington, D.C.
1710 Goodridge Dr., McLean, VA 22102
(703) 734-2500

Oak Ridge
800 Oak Ridge Tnpk., Oak Ridge, TN 37830
(615) 482-9031

Paramus
One Sears Drive, Paramus, NJ 07652
(201) 599-0100

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(303) 231-9094

Seattle
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(206) 747-7899

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(619) 535-7438

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Chain of Custo Record

Date 8-25-92 Page 1 of 1

Shipment No. 008

Name Tom Weatherly
Address 1710 Goodridge Dr. McLean Va 22102
Phone Number (703) 734-5584
Project Manager Al Wickline
Project Name Springfield ANGB
Job/P.O. No. 1-827-03-200-03
Sampler (Signature) (Printed Name)

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser way Federal Way, WA 98003
Phone (206) 924-6293
Contact Name Bonnie Chappel

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	TPH 8015	SVOC 8270	VOC 8240	P.P. Metals 6010	Sb 7041	As 7060	Pb 7421	Hg 7471	Sc 7740	Thallium 7487	Temp	TCLP		No. of Containers	Observations, Comments, Special Instructions
	Soil	TCLP-2	8-25-92	1600	Site 2												X		2	CFR Methods for TCLP
	Soil	TCLP-3	8-25-92	1645	Site 3												X		2	for Inorganic & Organic
	AQ	EB4-1	8-25-92	1800	CEBldg	X	X	X	X	X	X	X	X	X	X				5	
	AQ	FB4-1	8-25-92	1800	Site 4	X	X	X	X	X	X	X	X	X	X				5	All Metal Samples
	AQ	ERB6-1	8-25-92	1800	CEBldg	X	X	X	X	X	X	X	X	X	X				5	are preserved w
	AQ	FBB6-1	8-25-92	1800	CEBldg	X	X	X	X	X	X	X	X	X	X				5	Nitric Acid.
	AQ	TB-9	8-25-92					X											2	
	AQ	CB-9	8-25-92													X			1	
																				CB-9 temp 5°C

Total Number of Containers: 27

Relinquished by	Date	Received by	Date
Signature: John D. Pendleton (signature)	8/25/92	Signature	
Printed Name: John D. Pendleton	Time: 1900	Printed Name	Time
Company: SAIC		Company	

Relinquished by	Date	Received by	Date
Signature		Signature: Bobbie Foster (signature)	8/26/92
Printed Name	Time	Printed Name: Bobbie Foster	Time: 1030
Company		Company: WeyCo	

Instructions
1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method:

SAIC Location (circle)

Washington, D.C.
1710 Goodridge Dr., McLean, VA 22102
(703) 734-2500

Oak Ridge
800 Oak Ridge Tnpk., Oak Ridge, TN 37830
(615) 482-9031

Paramus
One Sears Drive, Paramus, NJ 07652
(201) 599-0100

Denver
1626 Cole Boulevard, Suite 270, Golden, CO 80401
(303) 231-9094

Seattle
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(206) 747-7899

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4224 Campus Point, Building 3, San Diego, CA 92121
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Fed Ex 4-1011-[illegible]

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Date 8/26/92 Page 1 of 1

Shipment No. 9

Name: Tom Weatherly
Address: 1710 Goodridge Dr. McLean VA
Phone Number: (703) 734-5584
Project Manager: Al Wickline
Project Name: Springfield ANGB SI
Job/P.O. No.: 1-827-03-200-03

Laboratory Name: Weyerhaeuser
Address: 32901 Weyerhaeuser Way Federal Way, WA 98003
Phone: (206) 924-6293
Contact Name: Bonnie Chappel

* Sampler (Signature): sample label says (Printed Name): time + date listed @ Weyco

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	TPH 8015	SVOC 8270	VOC 8240	P.P. Metals 6010	Sb 7041	As 7060	Pb 7421	Hg 7471	Se 7740	Thallium 7841	Temp	No. of Containers	Observations, Comments, Special Instructions
* MW3-1	Soil	MW3-1-1	8/26	1425	Site 3	X	X	X	X	X	X	X	X	X	X		3	
MW3-1R	Soil	MW3-1-1R	8/26	1425	Site 3	X	X	X	X	X	X	X	X	X	X		3	
SED2-1	Soil	SD2-1	8/26	1530	Site 2	X	X	X	X	X	X	X	X	X	X		3	
SED2-1R	Soil	SD2-1R	8/26	1530	Site 2	X	X	X	X	X	X	X	X	X	X		3	
SED2-2	Soil	SD2-2	8/26	1530	Site 2	X	X	X	X	X	X	X	X	X	X		3	
	Water	TB-10	8/26	—				X									2	
	Water	CB-10														X	1 ~~2~~	Only (1) One Coolant Blank (5.3)
	Soil	MW4-1-15	8/26	0857	Site 4	X		X	X			X					2	
	Soil	MW4-1-45	8/26	0930	Site 4	X		X	X			X					2	
	Soil	MW4-1-55	8/26	0934	Site 4	X		X	X			X					3	

Relinquished by: Signature: John D. Pendleton; Printed Name: John D. Pendleton; Company: SAIC; Date: 8/26/92; Time: 1900

Received by: Signature; Printed Name; Company; Date; Time

Relinquished by: Signature; Printed Name; Company; Date; Time

Received by: Signature: Bobbie Foster; Printed Name: Bobbie Foster; Company: Weyco; Date: 8/27/92; Time: 10:30

Total Number of Containers: 25

Instructions

1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method: Fed Ex

SAIC Location (circle)

Washington, D.C.
1710 Goodridge Dr., McLean, VA 22102
(703) 734-2500

Oak Ridge
800 Oak Ridge Tnpk., Oak Ridge, TN 37830
(615) 482-9031

Paramus
One Sears Drive, Paramus, NJ 07652
(201) 599-0100

Denver
1626 Cole Boulevard, Suite 270, Golden, CO 80401
(303) 231-9094

Seattle
13400B Northup Way, S38, Bellevue, WA 98005
(206) 747-7899

San Diego
4224 Campus Point, Building 3, San Diego, CA 92121
(619) 535-7438

...ns International Corporation

White: Laboratory Pink: Project Manager Yellow: Project QAO Goldenrod: Field Project Manager

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Chain of Custody Record

Date 8-27-92 Page 1 of 1

Shipment No. 0018

Name Tom Weatherk
Address 1710 Goodridge Dr. McLean VA. 22102
Phone Number (703) 734-5584
Project Manager Al Wickline
Project Name Springfield ANGB SI
Job/P O No 01-0822-03-0200-003
Sampler (Signature) John D. Pendleton (Printed Name) John D. Pendleton

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser Way
Federal Way, WA 98003
Phone (206) 924-6293
Contact Name Bonnie Chappel

Laboratory No	Matrix	Sample No	Date	Time	Site/Zone	TPH 8015	SVOC 8270	VOC 8240	~~7~~ Pb 7421	Temp	TCLP*								NO. OF CONTAINERS	OBSERVATIONS, COMMENTS, SPECIAL INSTRUCTIONS
	Soil	B1-5	8-27-92	0942	Site 1			X	X										2	* TCLP ANALYSIS → CFR
	Soil	B1-6	"	0912	Site 1			X	X										2	METHODS FOR ORGANICS +
	Soil	B1-7	"	0934	Site 1	X	X	X	X										2	INORGANICS
	Soil	B1-8	"	1012	Site 1	X	X	X	X										2	
	Soil	B1-8R	"	1012	Site 1	X	X	X	X										2	
	AQ	B1ER-2	"	0846	Site 1	X	X	X	X										5	All metal samples are
	AQ	B1FB-2	"	0846	Site 1	X	X	X	X										5	preserved w HNO3
	AQ	TB-11						X											2	
	AQ	CB-11								X									1	temp 3.7c at w:2400
	Soil	TCLP-4	"	1500	Site 4						X								1	8/28 1030

Relinquished by	Date	Received by	Date	Total Number of Containers: 24	Shipment Method
Signature: John D. Pendleton	8/27/92	Signature: Dana L. Schafer	8/28/92		
Printed Name: John D. Pendleton	Time	Printed Name: DANA L. Schafer	Time		
Company: SAIC	1900	Company: Weyerhaeuser	1030		
Relinquished by	Date	Received by	Date		
Signature		Signature			
Printed Name	Time	Printed Name	Time		
Company		Company			

Instructions
1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

SAIC Location (circle)

Washington, D.C.
1710 Goodridge Dr., McLean, VA 22102
(703) 734-2500

Oak Ridge
800 Oak Ridge Tnpk., Oak Ridge, TN 37830
(615) 482-9031

Paramus
One Sears Drive, Paramus, NJ 07652
(201) 599-0100

Denver
1626 Cole Boulevard, Suite 270, Golden, CO 80401
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(206) 747-7899

San Diego
4224 Campus Point, Building 3, San Diego, CA 92121
(619) 535-7438

Science Ar[illegible]ations International Corporation

White Laboratory Pink Project Manager Yellow Project QAO Goldenrod [illegible] Project Manager

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Date 9-29-92 Page 1 of 1

Shipment N[illegible] 0011

Name Tom Weatherly
Address 1710 Goodridge Dr McLean VA 22102
Phone Number 703 734 5584
Project Manager Al Wickline
Project Name Springfield SI
Job/P.O. No. 01 0827 03 0200 003
Sampler (Signature) (Printed Name)

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser Wy Federal Way, WA 98003
Phone 206 924 6293
Contact Name Bonnie Chappel

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	VOA 8010	VOA 8020	SVOC 8270	TPH 8015	P.P. Metals 6010	Sb 7041	As 7060	Pb 7421	Hg 7471	Se 7740	Thallium 7487	Temperature	No. of Containers	Observations, Comments, Special Instructions
	AQ	MWBG-2-1	9-29-92	1230	Backgr[illegible]	X	X	X	X	X	X	X	X	X	X	X		8	
	AQ	MW4-1-1	9-29-92	1250	Site 4	X	X	X	X	X	X	X	X	X	X	X		8	(*) see phone log
	AQ	ERBG-2	9-29-92	1140	Background	X	X	X	X	X	X	X	X	X	X	X		8	
	AQ	TB-12				X											X	1	
	AQ	CB-12																1	4.7°C
	AQ	TB-13					X											12 (T)	
													TOTAL					27	

Relinquished by	Date	Received by	Date
Signature: [signature]	9-29-92	Signature:	
Printed Name: Tom Weatherly	Time: 1700	Printed Name:	Time:
Company: SAIC		Company:	
Relinquished by	Date	Received by: Bobbie Foster	Date: 9/30/92
Signature:		Signature:	
Printed Name:	Time:	Printed Name: Bobbie Foster	Time: 1015
Company:		Company: Weyco	

Total Number of Containers:

Shipment Method:

Instructions

1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

SAIC Location (circle)

Washington, D.C. 1710 Goodridge Dr., McLean, VA 22102 (703) 734-2500

Oak Ridge 800 Oak Ridge Tnpk., Oak Ridge, TN 37830 (615) 482-9031

Paramus One Sears Drive, Paramus, NJ 07652 (201) 599-0100

Denver 1626 Cole Boulevard, Suite 270, Golden, CO 80401 (303) 231-9094

Seattle 13400B Northup Way, S38, Bellevue, WA 98005 (206) 747-7899

San Diego 4224 Campus Point, Building 3, San Diego, CA 92121 (619) 535-7438

White: Laboratory Pink: Project Manager Yellow: Project QAO Golden[illegible] d Project Manager

[illegible] Corporation

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Chain of Custody Rec ord

Date 9-30-92 Page 1 of 1

Shipment No. 0012

Name Tom Weatherly
Address 1710 Goodridge Dr McLean VA 22102
Phone Number 703 734 5584
Project Manager Al Wickline
Project Name Springfield St
Job/P.O. No. 01 0827 03 0200 003
Sampler (Signature) (Printed Name) Tom Weatherly

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser Way Federal Way, WA 98003
Phone 206 924 6293
Contact Name Bonnie Chappel

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	VOA 8010	VOA 8020	SVOC 8270	TPH 8015	P.P. Metals 6010	Sb 7041	As 7060	Pb 7421	Hg 7471	Se 7740	Thallium 7487	Temperature		No. of Containers	Observations, Comments, Special Instructions
	AQ	ERBA-1	9-30-92	1500	Background	X	X	X	X	X	X	X	X	X	X	X	X		8	
	AQ	EBBA-1	9-30-92	1500	"	X	X	X	X	X	X	X	X	X	X	X			8	
	AQ	MW G-1-1	9-30-92	1130	Background	X	X	X	X	X	X	X	X	X	X	X			8	Total Count = 80
	AQ	MW1-1-1	9-30-92	1030	Site 1	X	X	X	X	X	X	X	X	X	X	X			8	
	AQ	MW3-1-1	9-30-92	0930	Site 3	X	X	X	X	X	X	X	X	X	X	X			8	
	AQ	MWBG-1-2	9-30-92	1500	Blue Ash	X	X	X	X	X	X	X		X	X	X			7	
	~~AQ~~	~~TB-15~~																		
	AQ	TB-14	MWBG-1-2R			X	X												4	← TB-14
	AQ	~~TB-15~~	9-30-92	1500	Blue Ash	X	X	X	X	X	X	X	X	X	X	X			7	← MWBG-1-2R
	AQ	MW3-1-1R	9-30-92	0930	Site 3	X	X	X	X	X	X	X	X	X	X	X			8	
	AQ	MW3-1-1MS	9-30-92	0930	Site 3	X	X	X	X	X	X	X	X	X	X	X			8	
	AQ	MW2-1-2	9-30-92	1700	Blue Ash	X	X												2	
	AQ	CB-14															X		4	One Coolant Blank(s) Cooler

Relinquished by
Signature [signature]
Printed Name Tom Weatherly
Company SAIC
Date 9-30-92
Time 2030

Received by:
Signature
Printed Name
Company
Date
Time

Relinquished by
Signature
Printed Name
Company
Date
Time

Received by:
Signature Bonnie Chappel
Printed Name BONNIE CHAPPEL
Company Weyerhaeuser
Date 10/1/92
Time 1020

Total Number of Containers:

Instructions

1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method:

SAIC Location (circle)

Washington, D.C.
1710 Goodridge Dr., McLean, VA 22102
(703) 734-2500

Oak Ridge
800 Oak Ridge Tnpk., Oak Ridge, TN 37830
(615) 482-9031

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(206) 747-7899

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Chain of Custody Record

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Date 10-1-92 Page 1 of 1

Shipment No. 0013

Name TOM WEATHERLY
Address 1710 GOODRIDGE DR #
Phone Number 703 734 5584
Project Manager AL WICKLING
Project Name SPRINGFIELD ST
Job/P.O. No. 01 0827 03 0200 003
Sampler (Signature) (Printed Name) Tom Weatherly

Laboratory Name Weyerhaeuser
Address 32901 Weyerhaeuser Way Federal Way, WA 98003
Phone 206 924 6293
Contact Name Bonnie Chappel

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	VOA 8010	VOA 8020	SVOC 8270	TPH 8015	P.P. Metals 6010	Sb 7041	As 7060	Pb 7421	Hg 7471	Se 7740	Thallium 7487	Temperature	No. of Containers	Observations, Comments, Special Instructions
	AQ	FBCE-1	10-1-92	1320	CE Blg	X	X	X	X	X	X	X	X	X	X	X	[illegible]	8	
	AQ	MW2-1-1	10-1-92	1100	Site 2	X	X	X	X	X	X	X	X	X	X	X		7	←Minimum sample volume from MW2-1-1 due to poor recharge
	AQ	TB-15				X	X											2	
	AQ	CB-15															X	1	

TOTAL #: 18

Relinquished by	Date	Received by	Date
Signature: Tom Weatherly	10-1-92	Signature	
Printed Name: Tom WEATHERLY	Time: 1320	Printed Name	Time
Company: SAIC		Company	
Relinquished by	Date	Received by	Date: 10/2/92
Signature		Signature: Bobbie Foster	
Printed Name	Time	Printed Name: Bobbie Foster	Time: 1045
Company		Company: Weyco	

Total Number of Containers:

Instructions

1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method:

SAIC Location (circle)

Washington, D.C 1710 Goodridge Dr., McLean, VA 22102 (703) 734-2500

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Chain of Cu dy Record

Date 5/19/93 Page 1 of 1

~~COC~~ WPS 5/19/93

Shipment N 1001

Name Tom Weatherly
Address 1710 Goodridge Dr McLean, Va 22102
Phone Number (703) 734-5584
Project Manager Al Wickline
Project Name Springfield ANGB ST
Job/P.O. No. 01-0827-03-0200-

Sampler (Signature) [signature] (Printed Name) Tom Weatherly

Laboratory Name Weyerhauser
Address 32901 Weyerhauser Way S th, Federal Way, WA 98
Phone 2 6 924 4888
Contact Name KELLY

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	VOC 8240	SVOC 3550/8270	METALS SW846	TPH SW8015 MOD	Temp °C	No. of Containers	Observations, Comments, Special Instructions
9541	SOIL	SB2-4-1	5/19/93	0800	FTA 2	X	X	X	X		4	4°C F... all samples
9542	SOIL	SB2-4-2	5/19/93	0910	FTA 2	X	X	X	X		4	
9543	SOIL	SB2-5-1	5/19/93	1020	FTA 2	X	X	X	X		4	
9544	SOIL	SB2-5-2	5/19/93	1130	FTA 2	X	X	X	X		4	
9547	SOIL	SB3-4-1	5/19/93	1409	LCH-3	X	X	X	X		4	Product present
9548	SOIL	SB3-4-2	5/19/93	1435	LCH-3	X	X	X	X		4	
9549	SOIL	SB3-5-1	5/19/93	1525	LCH-3	X	X	X	X		4	Product present
9550	SOIL	SB3-5-2	5/19/93	1550	LCH-3	X	X	X	X		4	~~P~~ WPS 5/19/93
9545	SOIL	SB2-6-1	5/20/93	0725	FTA 2	X	X	X	X		4	
9546	SOIL	SB2-6-1R	5/20/93	0725	FTA 2	X	X	X	X	WPS 6/20/93	4	
[illegible]	WATER	TB52093	5/20/93	—	—	X					1	
[illegible]	*WATER	CB52093	5/20/93		—					X	1	*Temperature was 24°C
												Fedex shipment

Relinquished by
Signature [signature]
Printed Name Tom Weatherly
Company SAIC
Date ~~5/19/93~~ 5-20-93
Time ~~2200~~ 1900

Received by
Signature
Printed Name
Company
Date
Time

Relinquished by
Signature
Printed Name
Company
Date
Time

Received by
Signature [signature]
Printed Name [illegible]
Company
Date 5/21/93
Time 1100

Total Number of Containers: 42

Instructions
1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Metho
SAIC ~~Location~~ (circle)
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Paramus One Sears Drive, Paramus, NJ 07652 (201) 599-0100
Denver 1626 Cole Boulev... , Suite 270, Golden, CO 80401 (303) 231-9094
Seattle 13400B Northup W..., S38, Bellevue, WA 980.. (206) 747-7899
San Diego 4224 Campus Poi... Building 3, San ... (619) 535-7436

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Date 5/21/93 Page 1 of 3

1007 -

Name Tom Weatherly
Address 1710 Goodridge Dr. McLean, VA. 22102
Phone Number (703) 734-5584
Project Manager Al Wickline
Project Name Springfield ANGB SI
Job/P.O. No. 01-0827-03-0200

Sampler (Signature) (Printed Name) Tom Weatherly

Laboratory Name Weyerhauser
Address 32?1 Weyerhauser Way S. Federal Way, WA 98003
Phone (20?) 924 4088
Contact Name Kelly

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	VOC 8240	SVOC 3550/8270	TPH SW8015 Mod	Metals SW846		VOC E524.2	SVOC SW 3510/8270	TPH (gas) SW 8015Mod	TPH (diesel) SW8015Mod	Total PP Metals SW846	Dissolved PP metals		Temperature °C	No. of Containers	Observations, Comments, Special Instructions
9551	Soil	SD2-3	5/21/93	1334	FTA-2	X	X	X	X										2	4°C *EB 3-2 is
9552	Soil	SD2-4	5/21/93	1350	FTA-2	X	X	X	X										2	4°C from bailer.
9553	Soil	SD2-5	5/21/93	1407	FTA-2	X	X	X	X										2	4°C ** EB 2-2 is
9554	Soil	SD2-6	5/21/93	1426	FTA-2	X	X	X	X										2	4°C from soil
9555	Soil	SD3-1	5/21/93	1245	Leach Field	X	X	X	X										2	4°C sampling equip.
9556	Soil	SD3-2	5/21/93	1307	Leach Field	X	X	X	X										2	4°C NOTE: COC is for
9557	Soil	SD3-2R	5/21/93	1307	Leach Field	X	X	X	X										2	4°C 5 Coolers
	WATER	EB3-2	5/21/93	1815	LCH-3						X 4	X 1	X 2	X 1	X 1	X 1			10	Preserve all VOA & TPH(gas)
	WATER	EB3-2	5/21/93	1815	LCH-3						X 4	X 1	X 2	X 1	X 1	X 1			10	Water samples w/
	WATER	EB2-2	5/21/93	1815	FTA 2						X 4	X 1	X 2	X 1	X 1	X 1			10	HCL in the Lab
	WATER	EB2-2	5/21/93	1815	FTA 2						X 4	X 1	X 2	X 1	X 1	X 1			10	
	WATER	CB52193-03	5/21/93	—	—													X	1	Temp before shipping: 22°C
	WATER	CB52193-04	5/21/93	—	—													X	1	Temp before shipping: 22°C

Relinquished by
Signature [signature]
Printed Name Tom Weatherly
Company SAIC
Date 5/21/93 Time 2147

Received by
Signature
Printed Name
Company

Relinquished by
Signature
Printed Name
Company
Date Time

Received by
Signature Bonnie Chappel
Printed Name BONNIE CHAPPEL
Company Weyerhauser
Date 5-22-93 Time 1000

Total Number of Containers: 56

Shipment Method: Fed Ex

Instructions
1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

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Chain of Custody Record

Date 5/21/93 Page 2 of 3

Shipment ... 1002

Name Tom Weatherly
Address 1710 Goodridge Dr, McLean, VA 22102
Phone Number (703) 734-5584
Project Manager AL Wickline
Project Name Springfield ANG B SI
Job/P.O. No. 01-0827-03-0200-003
Sampler (Signature) Tom Weatherly (Printed Name) Tom Weatherly

Laboratory Name Weyerhauser
Address 32901 Weyerhauser Way South, Federal Way, Wa 98003
Phone (206) 924-4088
Contact Name Kelly

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	VOC E 524.2	SVOC SW3510/8270	TPH (gas) SW 8015 mod	TPH (diesel) SW 8015 mod	Total PP Metals SW846	Dissolved PP Metals SW846	Temp °C	No. of Containers	Observations, Comments, Special Instructions
9585	WATER	MW2-1-2	5/21/93	0915	FTA 2	4	1	2	1	1	1		10	Preserve all VOA &
9584	WATER	MW1-1-2	5/21/93	1030	FTA 1	4	1	2	1	1	1		10	TPH (gas) samples
9587	WATER	MW3-1-2	5/21/93	1415	LCH-3	4	1	2	1	1	1		10	in the lab.
9593	WATER	P-5-1	5/21/93	1310	FTA 2	4	1	2	1	1	1		10	
9591	WATER	P-4-1	5/21/93	1400	LCH-3	4	1	2	1	1	1		10	
9592	WATER	P-4-1R	5/21/93	1400	LCH-3	4	1	2	1	1	1		10	NOTE ON C of C
9589	WATER	MWBG1-2	5/21/93	1510	BKGD	4	1	2	1	1	1		10	states;
9590	WATER	MWBG-2-2	5/21/93	1515	BKGD	4	1	2	1	1	1		10	
9588	WATER	MW4-1-2	5/21/93	1625	POL	4	1	2	1	1	1		10	Preserve all VOA
9586	WATER	MW2-2-1	5/21/93	1655	FTA 2	4	1	2	1	1	1		10	+ TPH-G in lab
9579	WATER	TB 52193	5/21/93	—	—	X	[redacted]						1	
9578	WATER	CB52193-01	5/21/93	—	—	[redacted]							1	
9580	WATER	CB52193-02	5/21/93	—	—								1	

Total Number of Containers: 159

Relinquished by
Signature [signature]
Printed Name Tom Weatherly
Company SAIC
Date 5/21/93 Time 2147

Received by
Signature Bonnie Chappel
Printed Name BONNIE CHAPPEL
Company Weyerhauser
Date 5-22-93 Time 1000

Relinquished by
Signature
Printed Name
Company
Date Time

Shipment Method: Fed-ex

Instructions
1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

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Seattle 13400B Northup Way, S38, Bellevue, WA 98005 (206) 747-7899
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Chain of Cody Record

Date 5/21/93 Page 3 of 3

Shipment I 1002

Name Tom Weatherly
Address 1710 Goodridge Dr McLean, Va 22102
Phone Number (703) 734-5584
Project Manager AL Wickline
Project Name Springfield ANGB SI
Job/P.O. No 01-0829-03-0200-003

Sampler (Signature) (Printed Name) Tom Weatherly

Laboratory Name Weyerhauser
Address 32901 Weyerhauser Way S., Federal Way, WA 98003
Phone (206) 929-6043
Contact Name Kelly McAdam

Laboratory No.	Matrix	Sample No.	Date	Time	Site/Zone	Requested Parameters: Temperature	NO. OF CONTAINERS	OBSERVATIONS, COMMENTS, SPECIAL INSTRUCTIONS
	WATER	CB5219305	5/21/93	—	—	X	1	Temp before shipping: 20°C

Relinquished by	Date	Received by	Date
Signature: Wayne P. Storer	5/21/93	Signature	
Printed Name: Wayne P. Storer	Time 2147	Printed Name	Time
Company: SAIC		Company	

Relinquished by	Date	Received by	Date
Signature		Signature: Bonnie Chappell	5/22/93
Printed Name	Time	Printed Name: BONNIE CHAPPELL	Time 1000
Company		Company: Weyerhauser	

Total Number of Containers: 160

Instructions

1. Fill out form completely except for shaded areas (lab use only).
2. Complete in ballpoint pen. Draw one line through errors and initial.
3. Request analyses using EPA method numbers only. Consult the project QAPP for instructions. Complete as shown.
4. Reference all field QC samples to the applicable site or zone.
5. Note all applicable preservatives.
6. Group all sample containers and requested analyses from one sampling location together. Do not list individually.

Shipment Method: Fedex

SAIC Location (circle)

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(615) 482-9031

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(201) 599-0100

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1626 Cole Boulevard, Suite 270, Golden, CO 80401
(303) 231-9094

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13400B Northup Way, S38, Bellevue, WA 98005
(206) 747-7899

San Diego
4224 Campus Point, Building 3, San Diego, CA 92121
(619) 535-7438

White: Laboratory Pink: Project Manager Yellow: Project QAO Goldenrod: Field Project Manager

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Sampling Forms

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Sampling Form
(Field Sheet)

Project Name and Number: SPRINGFIELD ONGB 01-0827-03-0200-003
Sampling Crew: TOM WEATHERLY & PAUL PARRISH
Sampling Point Number: SD2-3
Sampling Location: FTA #2
Sample Type: ☐ GW ☐ SW ☐ Soil ☒ SED ☐ Other: ______
Date and Time Sample Collected: 5/21/93 1334
Weather Conditions: SUNNY, WARM ~70°F - 80°F & BREEZY

Purging Information (if applicable):

Method: ______
Quantity of Water Purged: ______
Disposition of Purge Water: ______

Date and Time of Purging: Start: ______ End: ______
Comments: ______

Groundwater:

Date and Time Collected: ______
Sampling Depth: ______
Water Level: ______
Sampling Method/Equipment: ______
Field Measurements: pH ______ Temp: ______ Cond: ______ Alkalinity: ______
Date and Time Filtered (if applicable): ______
Comments: ______

Surface Water:

Date and Time Collected: ______
Collection Method: ______
Date and Time Filtered (if applicable): ______
Field Measurements: pH ______ Temp: ______ Cond: ______ Turbidity: ______
Comments: ______

Soils/Sediment Sampling:

Date and Time Collected: 5/21/93 1334
Sampling Depth: 0"-8" BLS
Sampling Method: HAND AUGER, 6" Split Spoon type device
Comments: ______

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White: File Pink: Field Manager Yellow: Supervisory Geologist Goldenrod: Field Book

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Sampling Form
(Field Sheet)

Project Name and Number: SPRINGFIELD RANGE 01-0827-03-0200-003
Sampling Crew: TOM WEATHERLY & PAUL PARRISH
Sampling Point Number: SD2-4
Sampling Location: FTA # 2
Sample Type: ☐ GW ☐ SW ☐ Soil ☒ SED ☐ Other:
Date and Time Sample Collected: 5-21-93 1350
Weather Conditions: SUNNY, Warm ~70°-80°F & BREEZY

Purging Information (if applicable):
Method:
Quantity of Water Purged:
Disposition of Purge Water:
Date and Time of Purging: Start: End:
Comments:

Groundwater:
Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:
Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:
Date and Time Collected: 5-21-93 1350
Sampling Depth: 0"-8"
Sampling Method: HAND AUGER; 6" SPLIT SPOON type device
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: SPRINGFIELD ODNGB 01-0827-03-0200-003
Sampling Crew: TOM WEATHERLY & PAUL PARRISH
Sampling Point Number: SD 2-5
Sampling Location: FTA #2
Sample Type: ☐ GW ☐ SW ☐ Soil ☒ SED ☐ Other:
Date and Time Sample Collected: 5/21/93 1407
Weather Conditions: SUNNY, WARM ~ 70°-80° & BREEZY

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 5/21/93 1407
Sampling Depth: 0"-8" BLS
Sampling Method: HAND AUGER, 6" split spoon type device.
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: SPRINGFIELD CANGB 01082703020003

Sampling Crew: TOM WEATHERLY & PAUL PARRISH

Sampling Point Number: SD 2-6

Sampling Location: FTA #2

Sample Type: ☐ GW ☐ SW ☐ Soil ☒ SED ☐ Other

Date and Time Sample Collected: 5/21/93 1426

Weather Conditions: SUNNY, WARM ~ 70°-80° F & BREEZY

Purging Information (if applicable):

Method:

Quantity of Water Purged:

Disposition of Purge Water:

Date and Time of Purging: *Start:* *End:*

Comments:

Groundwater:

Date and Time Collected:

Sampling Depth:

Water Level:

Sampling Method/Equipment:

Field Measurements: pH Temp: Cond: Alkalinity:

Date and Time Filtered (if applicable):

Comments:

Surface Water:

Date and Time Collected:

Collection Method:

Date and Time Filtered (if applicable)

Field Measurements: pH Temp: Cond: Turbidity:

Comments:

Soils/Sediment Sampling:

Date and Time Collected: 5/21/93 1426

Sampling Depth: 0"-8"

Sampling Method: HAND AUGER: 6" split spoon type device

Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: SPRINGFIELD ORANGB 01-0827-03-0200~~0~~008

Sampling Crew: TOM WEATHERLY

Sampling Point Number: MW 2-1-1

Sampling Location: FTA 2

Sample Type: ☒ GW ☐ SW ☐ Soil ☐ SED ☐ Other

Date and Time Sample Collected: 10-1-92 ~~1100~~ 1355

Weather Conditions: PARTLY CLOUDY, COOL ~40°-50°F & BREEZY

Purging Information (if applicable):

Method: BAILED

Quantity of Water Purged: ~1.25 gals

Disposition of Purge Water: Drummed

Date and Time of Purging: Start: 10/1/92 1000 End: 10/1/92 1020

Comments:

Groundwater:

Date and Time Collected: 10/1/92 ~~1355~~ ~~1100~~ WPS 1355

Sampling Depth: ~24-27' BTOC

Water Level: ~~23.5' BTOC~~ WPS ~23.5' BTOC

Sampling Method/Equipment: BOTTOM FILLING TEFLON BAILER

Field Measurements: pH NR Temp: NR Cond: NR Alkalinity: —

Date and Time Filtered (if applicable): ~~NOT RECORDED~~ NR WPS

Comments: NR - NOT RECORDED

Surface Water:

Date and Time Collected:

Collection Method:

Date and Time Filtered (if applicable):

Field Measurements: pH Temp: Cond: Turbidity:

Comments:

Soils/Sediment Sampling:

Date and Time Collected:

Sampling Depth:

Sampling Method:

Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: SPRINGFIELD OANGB 01-0827-03-0200-003
Sampling Crew: TOM WEATHERLY
Sampling Point Number: MW2-1-2
Sampling Location: FTA 2
Sample Type: ☒ GW ☐ SW ☐ Soil ☐ SED ☐ Other
Date and Time Sample Collected: 5/21/93 0915
Weather Conditions: OVERCAST; COOL ~40°-50°F ~~&~~ BREEZY

Purging Information (if applicable):

Method: BAILED
Quantity of Water Purged: ~5 GALS
Disposition of Purge Water: DRUMMED

Date and Time of Purging: *Start:* 5/19/93 1522 *End:* 5/21/93 0915
Comments:

Groundwater:

Date and Time Collected: 5/21/93 0915
Sampling Depth: ~24'-27' BTOC
Water Level: ~23.6' BTOC
Sampling Method/Equipment: BOTTOM FILLING TEFLON BAILER
Field Measurements: pH NR Temp: NR Cond: NR Alkalinity:
Date and Time Filtered (if applicable): NOT-RECORDED (NR) 5/21/93
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable)
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected:
Sampling Depth:
Sampling Method:
Comments:

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White: File Pink: Field Manager Yellow: Supervisory Geologist Goldenrod: Field Book

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Sampling Form
(Field Sheet)

Project Name and Number: SPRINGFIELD ANGB 01082703020003
Sampling Crew: TOM WEATHERLY & Wayne STONER
Sampling Point Number: MW2-2-1
Sampling Location: FTA 2
Sample Type: ☒ GW ☐ SW ☐ Soil ☐ SED ☐ Other
Date and Time Sample Collected: 5/21/93 1655
Weather Conditions: SUNNY, WARM ~80° & CALM TO SL. BREEZY

Purging Information (if applicable):

Method: BAILED
Quantity of Water Purged: ~9 Gals
Disposition of Purge Water: Drummed

Date and Time of Purging: Start: 5/20/93 1215 End: 5/21/93 1005
Comments:

Groundwater:

Date and Time Collected: 5/21/93 1655
Sampling Depth: ~24 - 27' BTOC
Water Level: ~23.6' BTOC
Sampling Method/Equipment: BOTTOM FILLING TEFLON BAILER
Field Measurements: pH 7.48 Temp: 53.1 Cond: 560 Alkalinity: —
Date and Time Filtered (if applicable): NOT RECORDED 5/21/93
Comments: TIME WPS

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable)
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected:
Sampling Depth:
Sampling Method:
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: SPRINGFIELD OANGB 01082703020003

Sampling Crew: TOM WEATHERLY

Sampling Point Number: P-5-1

Sampling Location: —

Sample Type: ☒ GW ☐ SW ☐ Soil ☐ SED ☐ Other

Date and Time Sample Collected: 5/21/93 1310

Weather Conditions: SUNNY; WARM ~80°F & CALM TO ~~WE~~ WPS SL. BREEZY

Purging Information (if applicable):

Method: BAILED

Quantity of Water Purged: ~8 gals

Disposition of Purge Water: Drummed

Date and Time of Purging: *Start:* 5/19/93 0929 *End:* 5/21/93 1305

Comments:

Groundwater:

Date and Time Collected: 5/21/93 1310

Sampling Depth: ~6'-9' BTOC

Water Level: ~5.2' BTOC

Sampling Method/Equipment: BOTTOM FILLING TEFLON BAILER

Field Measurements: pH 7.65 Temp: 55.2°F Cond: 6.6 **Alkalinity:** —

Date and Time Filtered (if applicable): 5/21/93 TIME NOT RECORDED

Comments:

Surface Water:

Date and Time Collected:

Collection Method:

Date and Time Filtered (if applicable)

Field Measurements: pH Temp: Cond: **Turbidity:**

Comments:

Soils/Sediment Sampling:

Date and Time Collected:

Sampling Depth:

Sampling Method:

Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OANGB 01-0827-03-0000-003
Sampling Crew: John Pendelton, Tom Weatherly
Sampling Point Number: SB 3-1-1
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/19/92 1713
Weather Conditions: Overcast, slight drizzle, high in mid. 60's

Purging Information (if applicable):
Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:
Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:
Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:
Date and Time Collected: 8/19/92 1913
Sampling Depth: 0.5'-2.5'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OAGNB 01-0827-03-0000-003
Sampling Crew: Paul Parrish, John Pendelton, Tom Weatherly
Sampling Point Number: 3B3-1-8
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/20/92 0737
Weather Conditions:

Purging Information (if applicable):
Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:
Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:
Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:
Date and Time Collected: 8/20/92 0737
Sampling Depth: 14.5' - 16.5'
Sampling Method: Split spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OAGNB 01-0827-03-0200-003
Sampling Crew: Tom Wetherly, Paul Parrish, John Pendelton
Sampling Point Number: SB-3-2-1
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 4/20/92 0944
Weather Conditions: Clear and cool, highs in 70's

Purging Information (if applicable):
Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:
Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:
Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:
Date and Time Collected: 4/20/92 0944
Sampling Depth: 0.5' - 2.5'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OAGNB [illegible]
Sampling Crew: John Pendelton, Paul Parrish, Tom Weatherly
Sampling Point Number: SB-3-2-4
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/20/92 1000
Weather Conditions: Clear and cool, highs in 70's

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 8/20/92 1000
Sampling Depth: 6.5'-8.5'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OAGNB 01-0827-03-000-003
Sampling Crew: Paul Parrish, Tom Weatherly, John Pendelton
Sampling Point Number: SB-3-2-7
Sampling Location:
Sample Type: ☐ GW ☐ SW ☒ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/20/92 1053
Weather Conditions: Clear and cool, highs in 70's

Purging Information (if applicable):
Method:
Quantity of Water Purged:
Disposition of Purge Water:
Date and Time of Purging: Start: End:
Comments:

Groundwater:
Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:
Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:
Date and Time Collected: 8/20/92 1053
Sampling Depth: 12.5' - 14.0
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OAGNB 01-0827-03-0200-003
Sampling Crew: John Pendelton, Tom Weatherly, Paul Parrish
Sampling Point Number: SB 3-3-1
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/20/92 1158
Weather Conditions: Clear & cool, highs in 70's

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:
Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 8/20/92 1158
Sampling Depth: 0.5' - 2.5'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OAGNB 01-0827-03-2200-003
Sampling Crew: Tom Weatherly, John Pendelton, Bol Parrish
Sampling Point Number: 383-3-8
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/20/92 ~~14.5' 16.5'~~ 1419
Weather Conditions: Clear & Cool, highs in 70's

Purging Information (if applicable):
Method:
Quantity of Water Purged:
Disposition of Purge Water:
Date and Time of Purging: Start: End:
Comments:

Groundwater:
Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:
Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:
Date and Time Collected: 8/20/92 1419
Sampling Depth: 14.5'-16.5'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: SPRINGFIELD ANGB 01-0827-03-0200-003
Sampling Crew: TOM WEATHERLY
Sampling Point Number: SB3-4-1
Sampling Location: LEACH FIELD
Sample Type: ☐ GW ☐ SW ☒ Soil ☐ SED ☐ Other: ______
Date and Time Sample Collected: 5/19/93 1409
Weather Conditions: SUNNY, WARM ~70°-80°F & BREEZY

Purging Information (if applicable):

Method: ______
Quantity of Water Purged: ______
Disposition of Purge Water: ______

Date and Time of Purging: Start: ______ End: ______
Comments: ______

Groundwater:

Date and Time Collected: ______
Sampling Depth: ______
Water Level: ______
Sampling Method/Equipment: ______
Field Measurements: pH ______ Temp: ______ Cond: ______ Alkalinity: ______
Date and Time Filtered (if applicable): ______
Comments: ______

Surface Water:

Date and Time Collected: ______
Collection Method: ______
Date and Time Filtered (if applicable): ______
Field Measurements: pH ______ Temp: ______ Cond: ______ Turbidity: ______
Comments: ______

Soils/Sediment Sampling:

Date and Time Collected: 5/19/93 1409
Sampling Depth: ~7-9' BLS
Sampling Method: 3" OD Split Spoon
Comments: ______

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Sampling Form
(Field Sheet)

Project Name and Number: SPRINGFIELD OANGB 01-0827-03-0200-003
Sampling Crew: TOM WEATHEELY
Sampling Point Number: SB 3-4-2
Sampling Location: LEACH FIELD
Sample Type: ☐ GW ☐ SW ☒ Soil ☐ SED ☐ Other: ______
Date and Time Sample Collected: 5/17/93 1435
Weather Conditions: SUNNY, WARM ~70° - 80°F & BREEZY

Purging Information (if applicable):
Method: ______
Quantity of Water Purged: ______
Disposition of Purge Water: ______

Date and Time of Purging: Start: ______ End: ______
Comments: ______

Groundwater:
Date and Time Collected: ______
Sampling Depth: ______
Water Level: ______
Sampling Method/Equipment: ______
Field Measurements: pH ______ Temp: ______ Cond: ______ Alkalinity: ______
Date and Time Filtered (if applicable): ______
Comments: ______

Surface Water:
Date and Time Collected: ______
Collection Method: ______
Date and Time Filtered (if applicable): ______
Field Measurements: pH ______ Temp: ______ Cond: ______ Turbidity: ______
Comments: ______

Soils/Sediment Sampling:
Date and Time Collected: 5/17/93 1435
Sampling Depth: 12'-14' BLS
Sampling Method: 3" O.D. Split Spoon
Comments: ______

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Sampling Form
(Field Sheet)

Project Name and Number: SPRINGFIELD DANGB 01-0827-03-0200-003
Sampling Crew: TOM WEATHERLY
Sampling Point Number: SB 3-5-1
Sampling Location: LEACH FIELD
Sample Type: ☐ GW ☐ SW ☒ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 5/19/93 1525
Weather Conditions: SUNNY, WARM ~70°-80°F & BREEZY

Purging Information (if applicable):
Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:
Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:
Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:
Date and Time Collected: 5/19/93 1525
Sampling Depth: 6-8' BLS
Sampling Method: 3" O.D. Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: SPRINGFIELD ANGS 01-0827-03-0200-003
Sampling Crew: TOM WEATHERLY
Sampling Point Number: SB3-5-2
Sampling Location: LEACH FIELD
Sample Type: ☐ GW ☐ SW ☒ Soil ☐ SED ☐ Other: ______
Date and Time Sample Collected: 5/19/93 1550
Weather Conditions: SUNNY, WARM ~70°-80°F & BREEZY

Purging Information (if applicable):
Method: ______
Quantity of Water Purged: ______
Disposition of Purge Water: ______
Date and Time of Purging: Start: ______ End: ______
Comments: ______

Groundwater:
Date and Time Collected: ______
Sampling Depth: ______
Water Level: ______
Sampling Method/Equipment: ______
Field Measurements: pH ______ Temp: ______ Cond: ______ Alkalinity: ______
Date and Time Filtered (if applicable): ______
Comments: ______

Surface Water:
Date and Time Collected: ______
Collection Method: ______
Date and Time Filtered (if applicable): ______
Field Measurements: pH ______ Temp: ______ Cond: ______ Turbidity: ______
Comments: ______

Soils/Sediment Sampling:
Date and Time Collected: 5/19/93 1550
Sampling Depth: WPS ~~6'-8' BLS~~ 13'-15' BLS
Sampling Method: 3" O.D. Split Spoon
Comments: ______

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OANGB 01-0827-03-0200-003
Sampling Crew: John Rudelton, Paul Parrish, Tom Weatherly
Sampling Point Number: R-W3-1-1a
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/21/92 0809
Weather Conditions: Cool and Clear 57°F 1h 80°

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 8/21/92 0809
Sampling Depth: 0.5'-2.0'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OANGB 01-0827-03-0200-003
Sampling Crew: Paul Parrish, John Pendleton, Tom Weatherly
Sampling Point Number: MW 3-1-8
Sampling Location:
Sample Type: ☐ GW ☐ SW ☒ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/21/92 1040
Weather Conditions: Cool and Clear 57°F High 80

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 8/21/92 1040
Sampling Depth: 14'-16'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield ANGB 01-0237-03-0200-003
Sampling Crew: John Pendelton, Tom Weatherly, Paul Parrish
Sampling Point Number: MW3-1-1 MW3-1-1R
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 5/26/92 1425
Weather Conditions: N/A

Purging Information (if applicable):
Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:
Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:
Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:
Date and Time Collected: 5/26/92 1452
Sampling Depth: 6"
Sampling Method: Hand Auger
Comments:

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Sampling Form

(Field Sheet)

Project Name and Number: SPRINGFIELD ANGB 0108270302000003

Sampling Crew: TOM WEATHEELY & Paul PARRISH

Sampling Point Number: SD 3-1

Sampling Location: Leach field

Sample Type: ☐ GW ☐ SW ☐ Soil ☒ SED ☐ Other

Date and Time Sample Collected: 5/21/93 1245

Weather Conditions: SUNNY, Warm w/ ~70-80°F & BREEZY

Purging Information (if applicable):

Method:

Quantity of Water Purged:

Disposition of Purge Water:

Date and Time of Purging: *Start:* *End:*

Comments:

Groundwater:

Date and Time Collected:

Sampling Depth:

Water Level:

Sampling Method/Equipment:

Field Measurements: pH Temp: Cond: **Alkalinity:**

Date and Time Filtered (if applicable):

Comments:

Surface Water:

Date and Time Collected:

Collection Method:

Date and Time Filtered (if applicable)

Field Measurements: pH Temp: Cond: **Turbidity:**

Comments:

Soils/Sediment Sampling:

Date and Time Collected: 5/21/93 1245

Sampling Depth: 0"-8" BLS

Sampling Method: HAND AUGER, 6" Split spoon type device

Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: SPRINGFIELD OANGB 01082703020000Q3
Sampling Crew: TOM WEATHERLY & Paul PARRISH
Sampling Point Number: SD3-2 SD3-2R
Sampling Location: Leach field
Sample Type: ☐ GW ☐ SW ☐ Soil ☒ SED ☐ Other
Date and Time Sample Collected: 5/21/93 1307
Weather Conditions: Sunny, Warm @ 70-80°F & Breezy

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: *Start:* **End:**
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: **Alkalinity:**
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable)
Field Measurements: pH Temp: Cond: **Turbidity:**
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 5/21/93 1307
Sampling Depth: 0" - 8" BLS
Sampling Method: Hand Auger, 6" split spoon type device
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield 01-0827-03-0200-001
Sampling Crew: John Pendelton, Ron Smith, Tom Weatherly
Sampling Point Number: MW3-1-1 M3-1-1R
Sampling Location:
Sample Type: ☑ GW ☐ SW ☐ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 9/30/92 0930
Weather Conditions: Cool and Clear

Purging Information (if applicable):
Method: Teflon Bailer
Quantity of Water Purged: 28 gallons
Disposition of Purge Water:

Date and Time of Purging: Start: 9/29/92 1731 End: 9/29/92 1755
Comments:

Groundwater:
Date and Time Collected: 9/30/92 0930
Sampling Depth: 8.34'
Water Level: 8.34'
Sampling Method/Equipment: Teflon Bailer
Field Measurements: pH 7.86 Temp: 59.2 Cond: 10.41 Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:
Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:
Date and Time Collected:
Sampling Depth:
Sampling Method:
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: SPRINGFIELD OANGB 0108270302000003

Sampling Crew: TOM WEATHERLY

Sampling Point Number: MW3-1-2

Sampling Location: LEACH FIELD

Sample Type: ☒ GW ☐ SW ☐ Soil ☐ SED ☐ Other

Date and Time Sample Collected: 5/21/93 1415

Weather Conditions: SUNNY; WARM ~80°F & CALM TO SL. BREEZY

Purging Information (if applicable):

Method: PUMPED USING A SUBMERSIBLE PUMP

Quantity of Water Purged: ~30 gals

Disposition of Purge Water: Drummed

Date and Time of Purging: Start: 5/21/93 1241 End: 5/21/93 1314

Comments:

Groundwater:

Date and Time Collected: 5/21/93 1415

Sampling Depth: ~6-9' BTOC

Water Level: ~5.4' BTOC

Sampling Method/Equipment: BOTTOM FILLING TEFLON BAILER

Field Measurements: pH 7.98 Temp: 56.6 Cond: 7.17 Alkalinity: —

Date and Time Filtered (if applicable): 5/21/93 TIME NOT RECORDED

Comments:

Surface Water:

Date and Time Collected:

Collection Method:

Date and Time Filtered (if applicable)

Field Measurements: pH Temp: Cond: Turbidity:

Comments:

Soils/Sediment Sampling:

Date and Time Collected:

Sampling Depth:

Sampling Method:

Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: SPRINGFIELD OANGB 01082703020000 3

Sampling Crew: TOM WEATHERLY

Sampling Point Number: P-4-1 P-4-1R

Sampling Location: —

Sample Type: ☒ GW ☐ SW ☐ Soil ☐ SED ☐ Other

Date and Time Sample Collected: 5/21/93 1400

Weather Conditions: SUNNY, WARM ~ 80°F & CALM TO SL. BREEZY

Purging Information (if applicable):

Method: PUMPED USING A SUBMERSIBLE PUMP

Quantity of Water Purged: ~ 24-25 GALS

Disposition of Purge Water: DRUMMED

Date and Time of Purging: *Start:* 5/19/93 1040 *End:* 5/19/93 1119

Comments:

Groundwater:

Date and Time Collected: 5/21/93 1400

Sampling Depth: ~ 4'-7' BTOC

Water Level: ~ 3.5' BTOC

Sampling Method/Equipment: BOTTOM FILLING TEFLON BAILER

Field Measurements: pH NR Temp: NR Cond: NR **Alkalinity:**

Date and Time Filtered (if applicable): 5/21/93 TIME NOT RECORDED (NR)

Comments:

Surface Water:

Date and Time Collected:

Collection Method:

Date and Time Filtered (if applicable)

Field Measurements: pH Temp: Cond: **Turbidity:**

Comments:

Soils/Sediment Sampling:

Date and Time Collected:

Sampling Depth:

Sampling Method:

Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield ANGB 01-0827-03-0200-003
Sampling Crew: Tom Weatherly, John Pendelton, Paul Parish
Sampling Point Number: SB4-1-1
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/12/92 0753
Weather Conditions: Partially sunny, 63°, Hi near 74°

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 8/12/92 0753
Sampling Depth: 6"-2'-6"
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OAGNB 01-0827-03-0200-003
Sampling Crew: Tom Weatherly, Paul Parrish, John Pendelton
Sampling Point Number: SB4-125
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/12/92 0804
Weather Conditions: Partly sunny, 68°, Hi near 78°

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 8/12/92 0804
Sampling Depth: 2'6" - 4'-6"
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OAGNB 01-0827-03-0200-003
Sampling Crew: Tom Weatherby, Jason Pendelton, Paul Parish
Sampling Point Number: SB 6-2-1
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/12/92 1027
Weather Conditions: Partly Sunny, 63°, hi near 78°.

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 8/12/92 1027
Sampling Depth: 0.5'-2.5'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OAGNB 01-0827-03-0200-003
Sampling Crew: Tom Weatherly, Paul Parrish, John Pendleton
Sampling Point Number: SB 4-2-2
Sampling Location:
Sample Type: ☐ GW ☐ SW ☐ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/12/92 1032
Weather Conditions: Partly Sunny, 63°, hi near 78°

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 8/12/92 1036
Sampling Depth: 2.5' - 4.5'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OAGNB 01-0827-03-0200-003
Sampling Crew: Tom Weatherly, John Pendelton, Paul Parish
Sampling Point Number: SB 4-3-1 SB 4-3-1R
Sampling Location:
Sample Type: ☐ GW ☐ SW ☐ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 9/12/92 1352
Weather Conditions: Partly sunny 63°, Hi near 78°

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 9/12/92 1352
Sampling Depth: .5'-2.5'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OAGNB 01-0827-03-0200-003
Sampling Crew: Tom Weatherly, Paul Parrish, John Pendelton
Sampling Point Number: SB4-3-2
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/12/92 1359
Weather Conditions: Partly sunny 63°, Hi near 78°

Purging Information (if applicable):
Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:
Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:
Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:
Date and Time Collected: 8/12/92 1359
Sampling Depth: 2.5'-4.5'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OAGNB 01-0827-03-0200-002
Sampling Crew: John Pendelton, Paul Parrish, Tom Weatherly
Sampling Point Number: SB 4-3-3
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/12/92, 1424
Weather Conditions: Partly sunny 63°/ti near

Purging Information (if applicable):
Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:
Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:
Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:
Date and Time Collected: 8/12/92 1424
Sampling Depth: 4.5' - 6.5'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield SMVG13 01-0827-03-0200-003
Sampling Crew: Tom Weatherly, John Pendleton, Paul Parrish
Sampling Point Number: MW4-1-1S
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/26/92 0857
Weather Conditions: Clear with slight chance of rain High mid 80's

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 8/26/92 0857
Sampling Depth: 0.5' - 2.0'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Spring field OANGB 01-0827-03-0000-003
Sampling Crew: Tom Weatherby, John Pendleton, Paul Parish
Sampling Point Number: MW 4-4-4S
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/26/92 0930
Weather Conditions: Clear with slight chance of rain, High ~~mid~~ 80's

Purging Information (if applicable):
Method:
Quantity of Water Purged:
Disposition of Purge Water:
Date and Time of Purging: Start: End:
Comments:

Groundwater:
Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:
Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:
Date and Time Collected: 8/26/92 0930
Sampling Depth: 6.0' - 7.5'
Sampling Method: Split Spoon.
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield ANGB 01-0827-03-0200-003
Sampling Crew: Tom Weatherly, John Pendleton, Paul Parish
Sampling Point Number: MW4-1-SS
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/26/92 3934
Weather Conditions: Clear with slight chance of rain. High mid. 80's

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 8/26/92 0934
Sampling Depth: 8.0' - 9.5'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield 01-0827-03-0200-003
Sampling Crew: Tom Weatherly, John Pendelton, Ron Smith
Sampling Point Number: MW4-T-1
Sampling Location:
Sample Type: ☑ GW ☐ SW ☐ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 9/29/92 1250
Weather Conditions: Cold and Clear, Highs in the 60's Morning temperature, low 40's

Purging Information (if applicable):
Method: Teflon Bailer
Quantity of Water Purged: 246 gallons
Disposition of Purge Water:

Date and Time of Purging: Start: 9/29/92 0930 End: 9/29/92 1051
Comments:

Groundwater:
Date and Time Collected: 9/29/92 1250
Sampling Depth: 2.6' BTOC
Water Level: 2.6' BTOC
Sampling Method/Equipment: Teflon Bailer
Field Measurements: pH 7.42 Temp: 61.3 Cond: 6.38 Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:
Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:
Date and Time Collected:
Sampling Depth:
Sampling Method:
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: [illegible] [illegible] OANGB 01082703200-003
Sampling Crew: TOM WEATHERLY
Sampling Point Number: MW 4-1-2
Sampling Location: POL YARD
Sample Type: ☒ GW ☐ SW ☐ Soil ☐ SED ☐ Other
Date and Time Sample Collected: 5/21/93 1625
Weather Conditions: SUNNY, WARM ~ 80°F & CALM TO SL. BREEZY

Purging Information (if applicable):

Method: PUMPED USING A SUBMERSIBLE PUMP
Quantity of Water Purged: ~ 26 gals
Disposition of Purge Water: DRUMMED
Date and Time of Purging: *Start:* 5/20/93 1327 *End:* 5/20/93 1340
Comments:

Groundwater:

Date and Time Collected: 5/21/93 1625
Sampling Depth: ~ 2'-5' BTOC
Water Level: ~1.6' BTOC
Sampling Method/Equipment:
Field Measurements: pH 7.55 Temp: 55.5°F Cond: 550 Alkalinity: —
Date and Time Filtered (if applicable): 5/21/93 TIME NOT RECORDED
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable)
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected:
Sampling Depth:
Sampling Method:
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OAGNB 01-0827-03-02-00-003
Sampling Crew: Paul Parrish, John Pendleton, Tom Weatherly
Sampling Point Number: SB5-1-1
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/17/92 1426
Weather Conditions: 58°F, Clear, Hi upper 70's

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 8/17/92 1426
Sampling Depth: 5'-7'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OAGNB 01-0827-03-0200-002
Sampling Crew: John Pendleton, Paul Parish, Tom Weatherly
Sampling Point Number: SB 5-1-7
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/17/92 1543
Weather Conditions: 58° F, Clear, Upper 70's

Purging Information (if applicable):
Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:
Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:
Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:
Date and Time Collected: 8/17/92 1543
Sampling Depth: 25'-27'
Sampling Method: Split Spoon.
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield ANGB 01-0827-03-0200-008
Sampling Crew: Paul Parrish, John Pendleton, Tom Weatherly
Sampling Point Number: SB 5-2-1
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/18/92 0744
Weather Conditions: Sunny 60° Hi 78°

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 8/18/92 0744
Sampling Depth: 5'-7'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OAGNB 01-0827-03-0200-003
Sampling Crew: Tom Weatherly, John Pendleton, Paul Parrish
Sampling Point Number: SB5-2-2
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/18/92 0820
Weather Conditions: Sunny 60° Hi 78°

Purging Information (if applicable):
Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:
Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:
Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:
Date and Time Collected: 8/18/92 0820
Sampling Depth: 24'-26'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield OAGNB 01-0827-03-0200-003
Sampling Crew: Tom Weatherly, John Pendleton, Bill Parish
Sampling Point Number: SB 3-3-1
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 6/18/92 1112
Weather Conditions: Sunny 60° Hi 78°

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 6/18/92 1112
Sampling Depth: 6"-24" 0.5'-2.0'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield 01-0827-03-0200-003
Sampling Crew: Tom Weatherly, John Pendleton, Paul Parish
Sampling Point Number: SB 5-3-2
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/18/92
Weather Conditions: Sunny 60°F, Hi 78°F

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 8/18/92
Sampling Depth: 26.5'-28.5'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield [illegible] 01-0827-03-0000-083

Sampling Crew: Tom Weatherly, John Pendleton, Paul Parrish

Sampling Point Number: SB5-4- SB5-4-1R

Sampling Location:

Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:

Date and Time Sample Collected: 8/18/92 1540

Weather Conditions: Sunny 60° Hi 78°

Purging Information (if applicable):

Method:

Quantity of Water Purged:

Disposition of Purge Water:

Date and Time of Purging: Start: End:

Comments:

Groundwater:

Date and Time Collected:

Sampling Depth:

Water Level:

Sampling Method/Equipment:

Field Measurements: pH Temp: Cond: Alkalinity:

Date and Time Filtered (if applicable):

Comments:

Surface Water:

Date and Time Collected:

Collection Method:

Date and Time Filtered (if applicable):

Field Measurements: pH Temp: Cond: Turbidity:

Comments:

Soils/Sediment Sampling:

Date and Time Collected: 8/16/92 1540

Sampling Depth: 0.5' - 2.5'

Sampling Method: Split Spoon

Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield ANGB 01-0527-03-0001-7??
Sampling Crew: John Pendleton, Tom Weatherly, Paul Parrish
Sampling Point Number: SB5-4-2
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 9/16/92 1657
Weather Conditions: Sunny 60° Hi 78°

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 9/18/92 1657
Sampling Depth: ~~Split Spoon~~ 28.5' - 30.0'
Sampling Method: Split Spoon
Comments:

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Sampling Form
(Field Sheet)

01-082-7030200-003

Project Name and Number: Springfield ~~Blue Ash~~ Air National Guard

Sampling Crew: Tom Weatherly, Paul Parish

Sampling Point Number: SD5-1 (Springfield)

Sampling Location:

Sample Type: ☐ GW ☐ SW ☐ Soil ☒ SED ☐ Other:

Date and Time Sample Collected: 5 · 6 · 92 1420

Weather Conditions: NR

Purging Information (if applicable):

Method:

Quantity of Water Purged:

Disposition of Purge Water:

Date and Time of Purging: Start: End:

Comments:

Groundwater:

Date and Time Collected:

Sampling Depth:

Water Level:

Sampling Method/Equipment:

Field Measurements: pH Temp: Cond: Alkalinity:

Date and Time Filtered (if applicable):

Comments:

Surface Water:

Date and Time Collected:

Collection Method:

Date and Time Filtered (if applicable):

Field Measurements: pH Temp: Cond: Turbidity:

Comments:

Soils/Sediment Sampling:

Date and Time Collected: 5·6·92 1420

Sampling Depth: 6"

Sampling Method: Stainless Steel Trowel

Comments:

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Sampling Form
(Field Sheet)

01-0827-03-0200-003

Project Name and Number: Springfield ~~/Blue Ash~~ Air National Guard Base

Sampling Crew: Tom Weatherly, Paul Parish

Sampling Point Number: SD 5-2 (Springfield)

Sampling Location:

Sample Type: ☐ GW ☐ SW ☐ Soil ☑ SED ☐ Other:

Date and Time Sample Collected: 5·6·92 1405

Weather Conditions: NR

Purging Information (if applicable):

Method:

Quantity of Water Purged:

Disposition of Purge Water:

Date and Time of Purging: Start: End:

Comments:

Groundwater:

Date and Time Collected:

Sampling Depth:

Water Level:

Sampling Method/Equipment:

Field Measurements: pH Temp: Cond: Alkalinity:

Date and Time Filtered (if applicable):

Comments:

Surface Water:

Date and Time Collected:

Collection Method:

Date and Time Filtered (if applicable):

Field Measurements: pH Temp: Cond: Turbidity:

Comments:

Soils/Sediment Sampling:

Date and Time Collected: 5·6 92 1405

Sampling Depth: 6"

Sampling Method: Stainless Steel Trowel

Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: 01-0827-03-0200-003 Springfield

Sampling Crew: Tom Weatherly, Paul Parish

Sampling Point Number: SD 5-3, SD 5-3R

Sampling Location:

Sample Type: ☐ GW ☐ SW ☐ Soil ☑ SED ☐ Other:

Date and Time Sample Collected: 5·6·92 1355

Weather Conditions: NR

Purging Information (if applicable):

Method:

Quantity of Water Purged:

Disposition of Purge Water:

Date and Time of Purging: Start: End:

Comments:

Groundwater:

Date and Time Collected:

Sampling Depth:

Water Level:

Sampling Method/Equipment:

Field Measurements: pH Temp: Cond: Alkalinity:

Date and Time Filtered (if applicable):

Comments:

Surface Water:

Date and Time Collected:

Collection Method:

Date and Time Filtered (if applicable):

Field Measurements: pH Temp: Cond: Turbidity:

Comments:

Soils/Sediment Sampling:

Date and Time Collected: 5·6·92 1355

Sampling Depth: 6"

Sampling Method: Stainless Steel Trowel

Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield 01-0827-03-0200-003
Sampling Crew: Tom Weatherly, Paul Parish
Sampling Point Number: SP 5-4
Sampling Location:
Sample Type: ☐ GW ☐ SW ☐ Soil ☑ SED ☐ Other:
Date and Time Sample Collected: 5-6-92 1350
Weather Conditions: NR

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 5-6-92 1350
Sampling Depth: 6"
Sampling Method: Stainless Steel Trowel
Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield

Sampling Crew: Tom Weatherly, Paul Parish

Sampling Point Number: SD 5-5

Sampling Location:

Sample Type: ☐ GW ☐ SW ☐ Soil ☑ SED ☐ Other:

Date and Time Sample Collected: 5·6·92 1435

Weather Conditions: NR

Purging Information (if applicable):

Method:

Quantity of Water Purged:

Disposition of Purge Water:

Date and Time of Purging: Start: End:

Comments:

Groundwater:

Date and Time Collected:

Sampling Depth:

Water Level:

Sampling Method/Equipment:

Field Measurements: pH Temp: Cond: Alkalinity:

Date and Time Filtered (if applicable):

Comments:

Surface Water:

Date and Time Collected:

Collection Method:

Date and Time Filtered (if applicable):

Field Measurements: pH Temp: Cond: Turbidity:

Comments:

Soils/Sediment Sampling:

Date and Time Collected: 5·6·92 1435

Sampling Depth: 6"

Sampling Method: Stainless Steel Trowel

Comments:

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield 01-0827-03-0200 -003
Sampling Crew: Tom Weatherly, John Pendelton, Paul Parish, John Carter
Sampling Point Number: TCLP-2
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8·25·92 1600
Weather Conditions: NR

Purging Information (if applicable):
Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:
Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:
Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:
Date and Time Collected: 8·25·92 1600
Sampling Depth: NA
Sampling Method: Hand Auger
Comments: TCLP-2 is a composite sample collected from drummed cuttings of MW-2-1, SB-2-1 SB-2-2,

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield 01-0927,03-0200-003
Sampling Crew: John Carter, John Pendelton, Paul Brish, Tom Weatherly
Sampling Point Number: TCLP-3
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8·25·92 1645
Weather Conditions: NR

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 8·25·92 1645
Sampling Depth: –
Sampling Method: Hand Auger
Comments: TCLP-3 is a composite sample collected from drummed cuttings of SB-2-1 SB 3-2, SB3-3

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Sampling Form
(Field Sheet)

Project Name and Number: Springfield 01-0827-03-0200-003
Sampling Crew: Tom Weatherly, John Pendelton, Paul Parish
Sampling Point Number: TCLP-4
Sampling Location:
Sample Type: ☐ GW ☐ SW ☑ Soil ☐ SED ☐ Other:
Date and Time Sample Collected: 8/26/92 1345
Weather Conditions: NR

Purging Information (if applicable):

Method:
Quantity of Water Purged:
Disposition of Purge Water:

Date and Time of Purging: Start: End:
Comments:

Groundwater:

Date and Time Collected:
Sampling Depth:
Water Level:
Sampling Method/Equipment:
Field Measurements: pH Temp: Cond: Alkalinity:
Date and Time Filtered (if applicable):
Comments:

Surface Water:

Date and Time Collected:
Collection Method:
Date and Time Filtered (if applicable):
Field Measurements: pH Temp: Cond: Turbidity:
Comments:

Soils/Sediment Sampling:

Date and Time Collected: 8/26/92 1345
Sampling Depth:
Sampling Method: Hand auger
Comments: [illegible] composite sample collected from drummed cuttings of SB-4-3, MW4-1

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Water Level Measurement Forms

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Water Level Measurements
(Field Sheet)

Measurement Team: Paul Parrish, Tom Weatherly

Project Number and Location: Springfield OANGB SI
01-0827-03-0200-003

Measuring Method: Water level indicator

Measuring Point: Top of Casing

Well No.	Date	Time	Tape Reading		Depth to Water (ft)	Remarks
			Measure Pt.	Water Level		
P-1	5/5/92	0834	BTOC	7.2		
P-2	5/5/92	0827	BTOC	6.0'		
P-3	5/5/92	0820	BTOC	14.2'		
P-4	5/5/92	0813	BTOC	5.3'		
P-5	5/5/92	0806	BTOC	10.0'		
P-6	5/5/92	0756	BTOC	22.4'		

* Below Top of Casing (BTOC)

Measuring Point: Point where measurement was taken. Top of PVC casing (TOC); Top of Protective Steel Casing (TOSC); Land Surface (LS), etc.
Depth to Water: Measurements should be recorded to the nearest 0.01 ft. (e.g., 10.06 feet below TOC).
Remarks: Any conditions that may influence the water level measurements.

Disclaimer
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Water Level Measurements
(Field Sheet)

Measurement Team: Tom Weatherly

Project Number and Location: Springfield OANGBSI
01-0827-03-0200-003

Measuring Method: Water level Indicator

Measuring Point: Top of Casing

Well No.	Date	Time	Tape Reading		Depth to Water (ft)	Remarks
			Measure Pt.	Water Level		
P-1	8/10/92	NR	BTOC	14.12		
P-2	8/10/92	NR	BTOC	2.35		
P-3	8/10/92	NR	BTOC	15.72		
P-4	8/10/92	NR	BTOC	4.15		
P-5	8/10/92	NR	BTOC	7.05		
P-6	8/10/92	NR	BTOC	21.42		

* Below Top of Casing (BTOC)

Measuring Point: Point where measurement was taken. Top of PVC casing (TOC); Top of Protective Steel Casing (TOSC); Land Surface (LS), etc.
Depth to Water: Measurements should be recorded to the nearest 0.01 ft. (e.g., 10.06 feet below TOC).
Remarks: Any conditions that may influence the water level measurements.

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Water Level Measurements
(Field Sheet)

Measurement Team: John Pendelton, Paul Parish, Tom Weatherly

Project Number and Location: Springfield OANGB SI
01-0827-03-0200-003

Measuring Method: Water level Indicator

Measuring Point: Top of Casing

Well No.	Date	Time	Tape Reading		Depth to Water (ft)	Remarks
			Measure Pt.	Water Level		
P-1	6/11/92	744	BTOC	10.01'		
P-2	6/11/92	735	BTOC	2.16'		
P-3	6/11/92	749	BTOC	15.75'		
P-4	6/11/92	800	BTOC	4.13'		
P-5	6/11/92	811	BTOC	6.79'		
P-6	6/11/92	807	BTOC	21.44'		

* Below Top of Casing (BTOC)

Measuring Point: Point where measurement was taken. Top of PVC casing (TOC); Top of Protective Steel Casing (TOSC); Land Surface (LS), etc.
Depth to Water: Measurements should be recorded to the nearest 0.01 ft. (e.g., 10.06 feet below TOC).
Remarks: Any conditions that may influence the water level measurements.

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Water Level Measurements
(Field Sheet)

Measurement Team: Tom Weatherly, John Pendelton, Paul Parish

Project Number and Location: Springfield OANGB
01-0827-03-0200-003

Measuring Method: Water level Indicator

Measuring Point: Top of Casing

Well No.	Date	Time	Tape Reading: Measure Pt.	Tape Reading: Water Level	Depth to Water (ft)	Remarks
P-1	8/25/92	1221	BTOC	11.37'		
P-2	8/25/92	1211	BTOC	3.14'		
P-3	8/25/92	1201	BTOC	16.90'		
P-4	8/25/92	1120	BTOC	4.60'		
P-5	8/25/92	1155	BTOC	8.24'		
P-6	8/25/92	1135	BTOC	21.92'		
MWBG1	8/25/92	1205	BTOC	8.69		
MWBG2	8/25/92	1215	BTOC	4.21		
MW2-1	8/25/92	1138	BTOC	24.34		
MW22	8/25/92	1143	BTOC	14.44		

* Below Top of Casing (BTOC)

Measuring Point: Point where measurement was taken. Top of PVC casing (TOC); Top of Protective Steel Casing (TOSC); Land Surface (LS), etc.
Depth to Water: Measurements should be recorded to the nearest 0.01 ft. (e.g., 10.06 feet below TOC).
Remarks: Any conditions that may influence the water level measurements.

Disclaimer

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Water Level Measurements

(Field Sheet)

Measurement Team: John Pendelton

Project Number and Location: Springfield OANGB SI
01-0827-03-0200-003

Measuring Method: Water level Indicator

Measuring Point: Top of Casing

Well No.	Date	Time	Tape Reading		Depth to Water (ft)	Remarks
			Measure Pt.	Water Level		
P-1	9/25/92	1037	BTOC	11.76'		
P-2	9/25/92	1045	BTOC	3.12'		
P 3	9/25/92	1103	BTOC	17.54'		
P 4	9/25/92	1103	BTOC	4.53'		
P-5	9/28/92	1103	BTOC	9.46'		
P-6	9/28/92	1103	BTOC	22.47'		
P-7	9/25/92	1103	BTOC	16.26'		
P-8	9/28/92	1118	BTOC	4.93'		
MWBG1	9/28/92	1055	BTOC	12.05'		
MWBG2	9/25/92	1033	BTOC	5.09'		
MW-1	9/28/92	1033	BTOC	15.55		
MW-2	9/25/92	1033	BTOC	NR		
MW3 1	9/29/92	1134	BTOC	8.34'		
MW4-1	9/29/92	1134	BTOC	2.33'		

* BTOC (Below top of Casing)

Measuring Point: Point where measurement was taken. Top of PVC casing (TOC); Top of Protective Steel Casing (TOSC); Land Surface (LS), etc.
Depth to Water: Measurements should be recorded to the nearest 0.01 ft. (e.g., 10.06 feet below TOC)
Remarks: Any conditions that may influence the water level measurements.

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Water Level Measurements
(Field Sheet)

Measurement Team: Wayne Stoner and Tom Weatherly

Project Number and Location: 01-0827-03-0200- Springfield Air National Guard Base

Measuring Method: INTERFACE PROBE

Measuring Point: V. NOTCH ON WELL RISER

Well No.	Date	Time	Tape Reading		Depth to Water (ft)	Remarks
			Measure Pt.	Water Level		
MW 1-1	5/19/93	0829	TOC	10.41		
P-6	|	0900	|	19.46		
P-5	|	0901	|	5.20		
P-7	|	1008	|	9.97		
P-4	|	1032	|	3.45		
P-8	|	1450	|	3.47		
P-1	|	1500	|	11.24		
MWBG-2	|	1519	|	1.98		
P-2	|	1526	|	1.56		
MWBG-1	|	1535	|	4.48		
P-3	|	1542	|	13.89		
MW 3-1	5/19/93	1655	|	4.96		
MW 2-1	5/20/9	0900	|	23.56		

Measuring Point: Point where measurement was taken. Top of PVC casing (TOC); Top of Protective Steel Casing (TOSC); Land Surface (LS), etc.
Depth to Water: Measurements should be recorded to the nearest 0.01 ft. (e.g., 10.06 feet below TOC).
Remarks: Any conditions that may influence the water level measurements.

Disclaimer
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Well Development Forms

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Well Development Form
(Field Sheet)

Project Name and Number: Springfield 01-0827-03-0200-003

Well Number and Location: MWBG-1

Development Crew: John Carter, John Pendelton, Paul Parrish   Driller (if applicable): ____

Water Levels/Time: Initial: NR   Pumping: ____   Final: NR

Total Well Depth: Initial: NR   Final: NR

Date and Time: Begin: 8/27/92 1610   Completed: 8/28/92 1000

Development: Method(s): Surge Block

Total Quantity of Water Removed: 20.3 gals

Date/Time ~~and Pump Setting~~	Gallons Pumped Discharge Rate* ~~and~~ ~~Measurement~~ Method	Field Measurements: Temp (°F)	Specific Conductivity (umhos/cm)	pH (Standard Units)	Turbidity	Remarks (Including Sand Production)
8/27/92 1610	5gals/NR					
1710	5gals/NR					
2000	2.3gals/NR					
8/28/92 0907	—	—	0.44	7.44		
0914	6 gals	—	044	7.60		
0950	2gals	—	0.42	7.45		

*gallons per minute or bailer capacity

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Well Development Form
(Field Sheet)

Project Name and Number: Springfield 01-0827-03-0200-003

Well Number and Location: MWBG-2

Development Crew: John Carter, John Pendelton, Paul Parrish Driller (if applicable):

Water Levels/Time: Initial: Pumping: Final:

Total Well Depth: Initial: NR Final: NR

Date and Time: Begin: 8/27/92 1458 Completed: 8/27/92 1530

Development: Method(s): Surge Block

Total Quantity of Water Removed: 12 gals

Date/Time and Pump Setting	Discharge Rate* and Measurement Method	Field Measurements				Remarks (Including Sand Production)
		Temp (°F)	Specific Conductivity (umhos/cm)	pH (Standard Units)	Turbidity	
8/27/92 1458	4 gals/NR	68.8	5.75	7.46		
1512	4 gals/NR	70.7	5.69	7.52		
1530	4 gals/NR	68.6	5.20	7.55		

*gallons per minute or bailer capacity

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Well Development Form
(Field Sheet)

Project Name and Number: Springfield 01-0827-03-0200-003

Well Number and Location: MW 1-1-1

Development Crew: John Carter, John Pendelton, Paul Parrish   Driller (if applicable): Jeff Childs, Todd Sine

Water Levels/Time: Initial: 14.79' TOC 0800 Pumping: ______ Final: 14.92' TOC 1603

Total Well Depth: Initial: NR Final: NR

Date and Time: Begin: 8/27/92 1256 Completed: 8/28/92 0925

Development: Method(s): Surge Block

Total Quantity of Water Removed: ~~48.5~~ 51.5 gals

Date/Time and Pump Setting	Discharge Rate* and Measurement Method	Field Measurements: Temp (°F)	Specific Conductivity (umhos/cm)	pH (Standard Units)	Turbidity	Remarks (Including Sand Production)
8/27/92 0814	1.5 gals/NR	—	—	—		
0856	5 gals/NR	68.3°	2.03	7.30		
0912	4 gals/NR	—	—	—		
0930	3 gals/NR	—	—	—		
1001	3 gals/NR					
1027	4 gals/NR	77.8°	2.40	7.90		
1052	4 gals/NR	—	—	—		
1120	3 gals/NR	—	—	—		
1235	4 gals/NR	—	—	—		
1314	5 gals/NR	—	—	—		
1349	4 gals/NR	70.3°	6.64	7.74		
1355	4 gals/NR	—	—	—		
1605	1 gal/NR	63.5°	15.78	10.25		
8/28/92 0925	3 gals/NR	—	—	—		
8/26/92 1558	3 gals/NR	—	0.56	7.23		

*gallons per minute or bailer capacity

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Well Development Form
(Field Sheet)

Project Name and Number: Springfield 01-0827-03-0200-003

Well Number and Location: MW 2-1

Development Crew: John Carter, John Pendelton, Paul Parrish   Driller (if applicable):

Water Levels/Time: Initial: 24.54' TOC 1324 Pumping: Final: NR

Total Well Depth: Initial: NR Final: NR

Date and Time: Begin: 5/27/92 1547 Completed: NR

Development: Method(s): Surge Block

Total Quantity of Water Removed: 2 gals

Date/Time ~~and Pump Setting~~	Gallons pumped Discharge Rate* ~~and Measurement Method~~	Field Measurements Temp (~~°C~~)	Specific Conductivity (umhos/cm)	pH (Standard Units)	Turbidity	Remarks (Including Sand Production)
5/27/92 1547	2 gals/NK	65°	7.42	7.91		
0945	Not enough water in well to pump well.					

*gallons per minute or bailer capacity

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Well Development Form
(Field Sheet)

Project Name and Number: SPRINGFIELD OANGB 01-0827-03-020

Well Number and Location: MW 2-2 FTA 2

Development Crew: TOM WEATHERLY Driller (if applicable): JESSIE FEARING

Water Levels/Time: Initial: ~ 22.4 Pumping: PUMPED DRY Final: ~~~23~~ N/A WPS

Total Well Depth: Initial: — Final: —

Date and Time: Begin: 5/20/93 Completed: 5/21/93

Development: Method(s): PUMPED W/ A SUBMERSIBLE PUMP & BAILED.

Total Quantity of Water Removed: 9 gals

Date/Time and Pump Setting	Discharge Rate* and Measurement Method	Field Measurements				~~Remarks~~ (Including Sand Production)
		Temp ~~(°C)~~ WPS	Specific Conductivity (umhos/cm)	pH (Standard Units)	Turbidity	
5/20/93 1200	PUMPED DRY	—	—	—	—	VERY CLOUDY AND SILTY. THIS WELL IS A VERY SLOW RECHARGE
5/21/93 1005	PUMPED DRY	53.1°F	560	7.48	—	KEPT PUMPING WELL DRY ~~TO~~ WPS ~~DURING~~ DEVELOPMENT

*gallons per minute or bailer capacity

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Well Development Form
(Field Sheet)

Project Name and Number: Springfield 01-0827-03-0200-003

Well Number and Location: MWB-1

Development Crew: John Carter / John Pendleton / Paul Parrish Driller (if applicable):

Water Levels/Time: Initial: 6.12' TOC 1745 Pumping: Final: NR

Total Well Depth: Initial: NR Final: NR

Date and Time: Begin: 8/27/92 1800 Completed:

Development: Method(s): Surge Block

Total Quantity of Water Removed: 20 gals

Date/Time and ~~Pump Setting~~	Gallons pumped Discharge Rate* ~~and Measurement Method~~	Field Measurements				Remarks (Including Sand Production)
		Temp (°C)	Specific Conductivity (umhos/cm)	pH (Standard Units)	Turbidity	
8/27/92 1810	4 gals/NR	66.1°	5.40	7.63		
1835	2 gals/NR					
1918	3 gals/NR					
8/28/92 0739	3 gals/NR					
0757	2 gals/NR					
0815	3 gals/NR					
0856	3 gals/NR					

*gallons per minute or bailer capacity

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Well Development Form
(Field Sheet)

Project Name and Number: Springfield 01-0827-03-0200-003

Well Number and Location: MW4-1

Development Crew: John Carter, John Pendelton, Paul Parrish   Driller (if applicable):

Water Levels/Time: Initial: NR   Pumping: Final: NR

Total Well Depth: Initial: NR   Final: NR

Date and Time: Begin: 5/28/92 1118   Completed: 5/28/92 1135

Development: Method(s): Surge Block

Total Quantity of Water Removed: 4 gals

Date/Time ~~and Pump Setting~~	Gallons Pumped Discharge Rate* ~~and Measurement Method~~	Field Measurements				Remarks (Including Sand Production)
		Temp (°F)	Specific Conductivity (umhos/cm)	pH (Standard Units)	Turbidity	
5/28/92 1118	4 gal/NR	62.8	5.06	7.90		
*No more information was recorded.						

*gallons per minute or bailer capacity

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APPENDIX L

Field Variances

MEMORANDUM

DATE: August 17, 1992

TO: Tom Cady/Mary Bridgewater

FROM: Al Wickline AW

SUBJECT: Changes to Springfield/Blue Ash SI field effort.

Based on information and data collected during the initial activities at Springfield Air National Base four changes to the planned activities are warranted. These changes and the rationales are presented below.

- The second background/upgradient monitoring well will be drilled and installed in the parking lot west of the CE building (Building 131). This location is based on the ground water elevation plotted during the first week of the field effort.

- The downgradient monitoring well for Site 4 (POL Storage area) will be relocated to a downgradient position. Based on the plotted ground water flow direction the well will be located near the Soil Gas transect point D-9. This location as well as the initial location are shown on Figure 2-4.

- The location of the downgradient monitoring well at Site 1 (FTA-1) was relocated from the planned location (Soil Gas point C-10) to the location shown on Figure 2-1 (Soil Gas point I-10). This location is downgradient from the site based on the water elevations plotted at the beginning of the field effort.

- Because of the unusual ground water elevations in the center of the Base the installation of an additional piezometer near buildings 122, 103, or 102 may be necessary to obtain an accurate flow direction and rate across the Base. As additional information from the ongoing investigation is obtained it may be necessary to install this monitoring point.

The attached figures show the locations of the planned soil borings and monitoring wells as well as the proposed changes. The proposed changes are just inked in because I did not have time to get the graphics done. As these locations are finalized and installed the figures will be cleaned up. If you have any questions feel free to call at (703) 734-5514.

Attachments:

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SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

FAXED 8/20/92 8:00am

FAX SHEET

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
ENVIRONMENTAL COMPLIANCE GROUP
APPLIED TECHNOLOGY DIVISION
1710 GOODRIDGE DRIVE
M/S T2-4-1
McLEAN, VIRGINIA 22102
FAX: (703)506-9689

COVER SHEET PLUS 13 PAGES

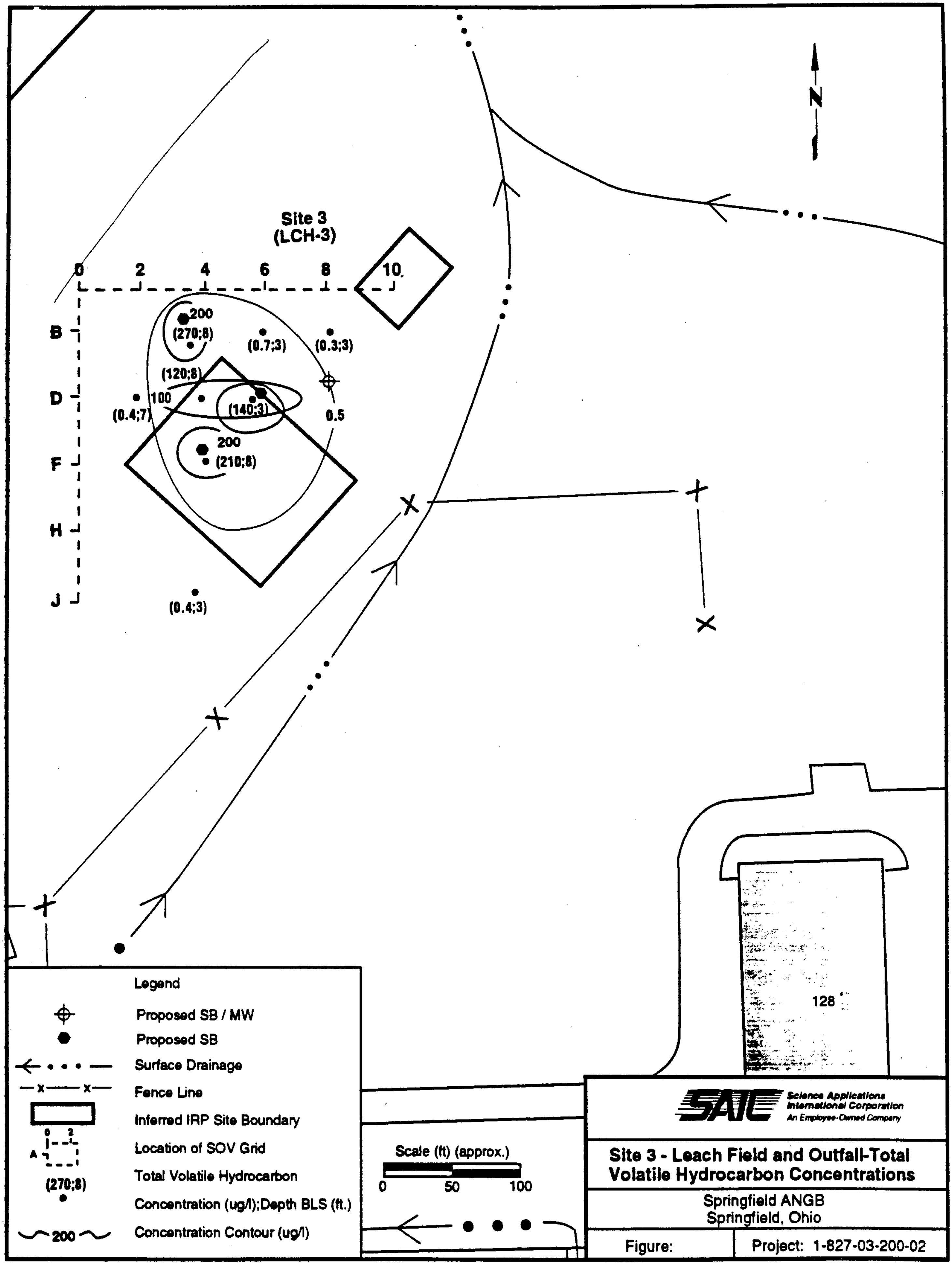
TO: MARY BRIDGWATER	FAX: (301) 981-8151
FROM: AL WICKLINE	PHONE: (703) 734-5514

MESSAGE

Mary, Here is a set of data on the field screening results from the drilling at Springfield. Also attached are the up to date soil boring and monitoring well locations

Al Wickline

URGENT		NORMAL
DATE: 8/20/92	TIME: 6:50 am	SENT BY: AW
CHARGE NUMBER: 01-0827-03-0200-003		


Site 3
(LCH-3)
0
2
4
6
8
10
B
D
F
H
J
200
(270;8)
(0.7;3)
(0.3;3)
(120;8)
100
(0.4;7)
(140;3)
0.5
200
(210;8)
(0.4;3)
N
128
Legend
Proposed SB / MW
Proposed SB
Surface Drainage
Fence Line
Inferred IRP Site Boundary
Location of SOV Grid
Total Volatile Hydrocarbon
Concentration (ug/l);Depth BLS (ft.)
Concentration Contour (ug/l)
Scale (ft) (approx.)
0
50
100
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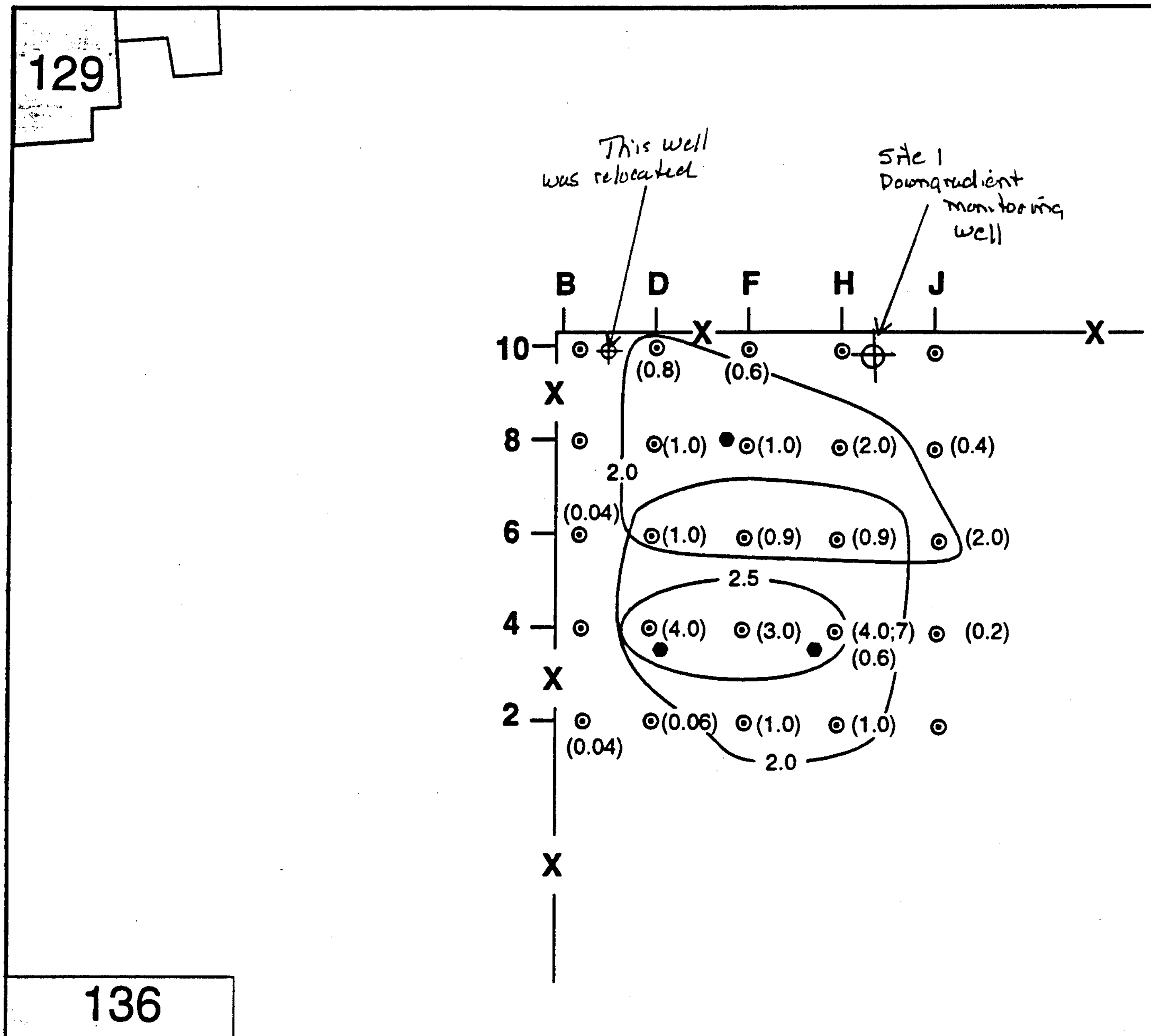
Site 3 - Leach Field and Outfall-Total Volatile Hydrocarbon Concentrations
Springfield ANGB
Springfield, Ohio
Figure:
Project: 1-827-03-200-02



Legend

- Proposed Monitoring Well
- Proposed SB
- Fence Line
- Inferred IRP Site Boundary
- Location of SOV Grid
- (270;8) Total Volatile Hydrocarbon Concentration (ug/l)
- All Samples Collected at 2 ft. BLS Except Where Noted

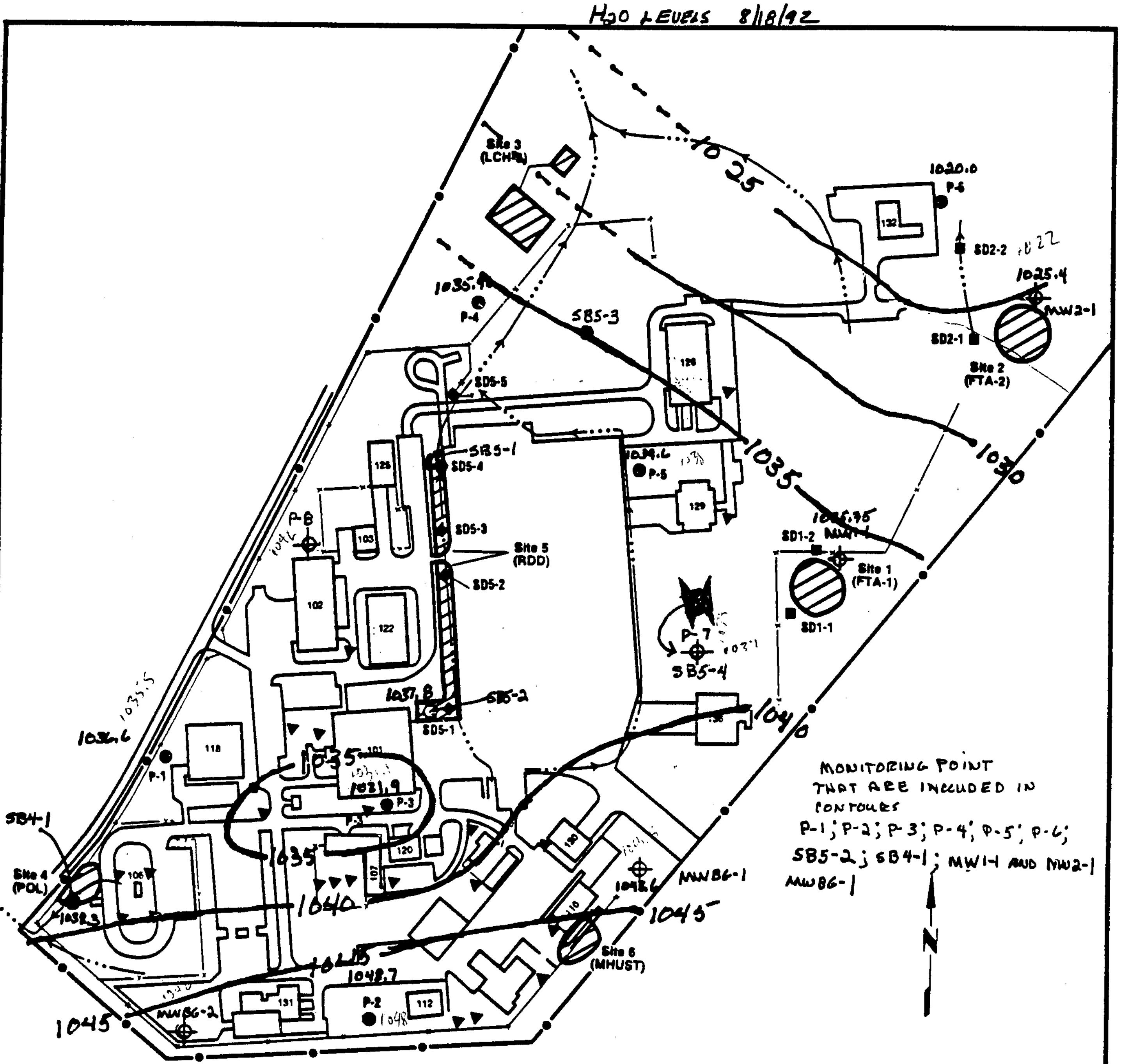
SAIC Science Applications International Corporation An Employee-Owned Company

Site 1 - Fire Training Area (FTA-1)-Total Volatile Hydrocarbon Concentrations

Springfield ANGB
Springfield, Ohio

Figure: 2-1	Project: 1-827-03-200-02

H2O LEVELS 8/18/92



Legend

- Proposed Backround SB / MW
- Proposed SB
- Site 5 Soil Boring
- P-1 Piezometer
- SD5-1 Sediment Sampling Location
- Base Boundary
- Surface Drainage
- Fence Line
- IRP Sites
- USTs (approx. locations)

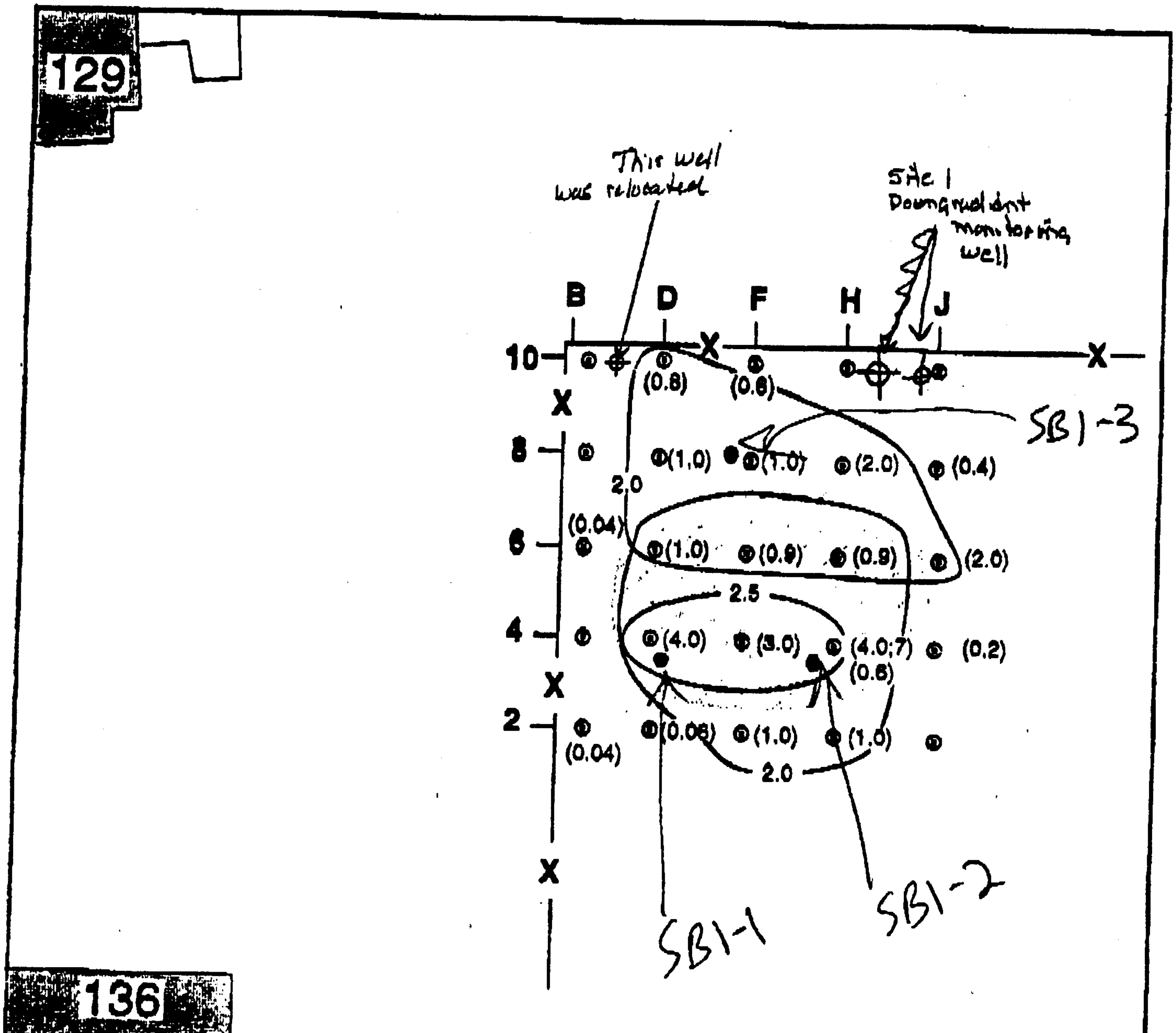
Scale (ft) (approx.)
0 150 300

SAIC Science Applications International Corporation An Employee-Owned Company

Piezometer and Sediment Sample Locations

Springfield ANGB
Springfield, Ohio

Figure: 1 | Project: 1-827-03-200-02



Legend

- Proposed Monitoring Well
- Proposed SB
- Fence Line
- Inferred IRP Site Boundary
- Location of SOV Grid
- (279.5) Total Volatile Hydrocarbon Concentration (ug/l)
- All Samples Collected at 2 ft. BLS Except Where Noted

Science Applications International Corporation
An Employee-Owned Company

Site 1 - Fire Training Area (FTA-1)-Total Volatile Hydrocarbon Concentrations

Springfield ANGB
Springfield, Ohio

Figure: 2-1 | Project: 1-827-03-200-02

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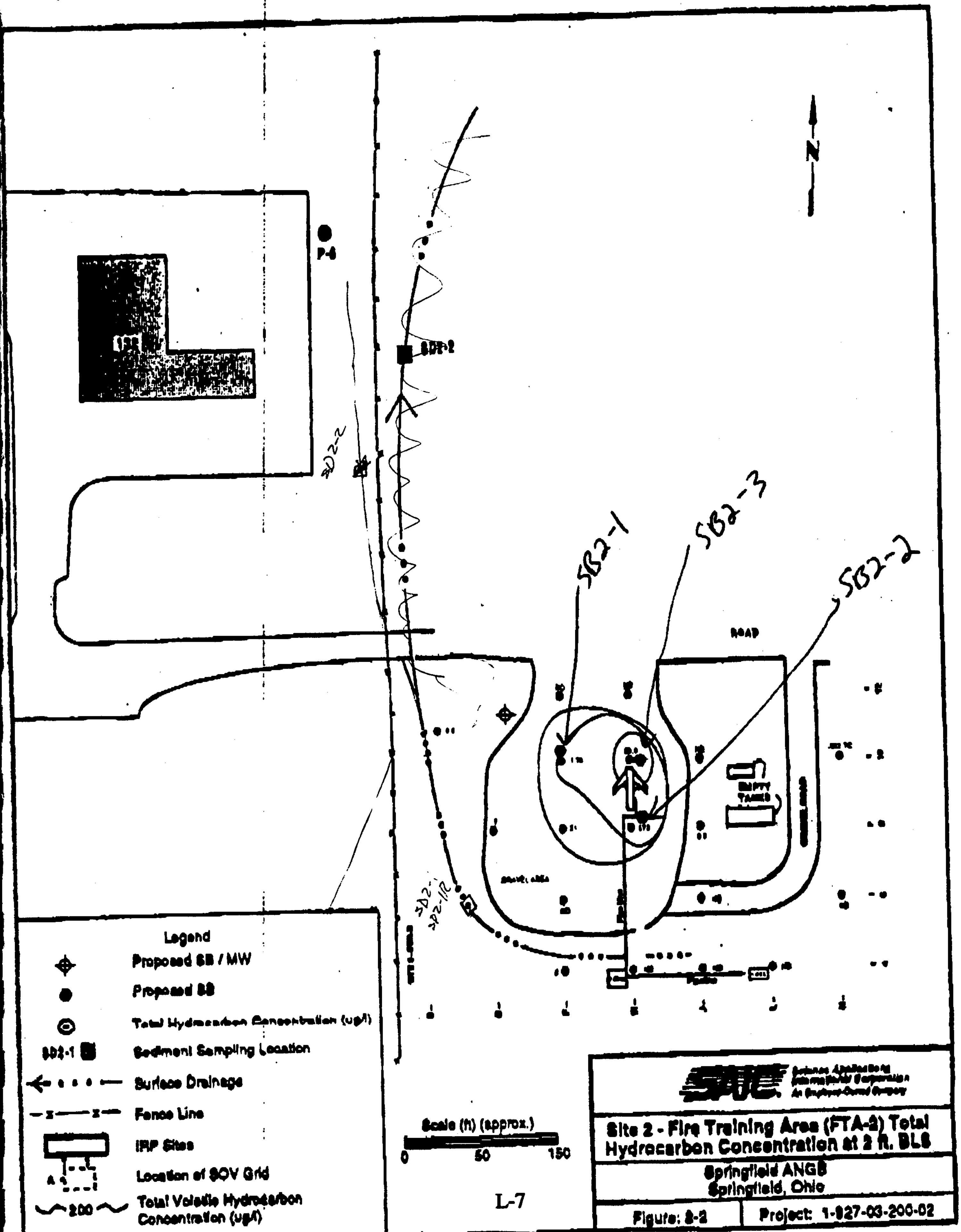

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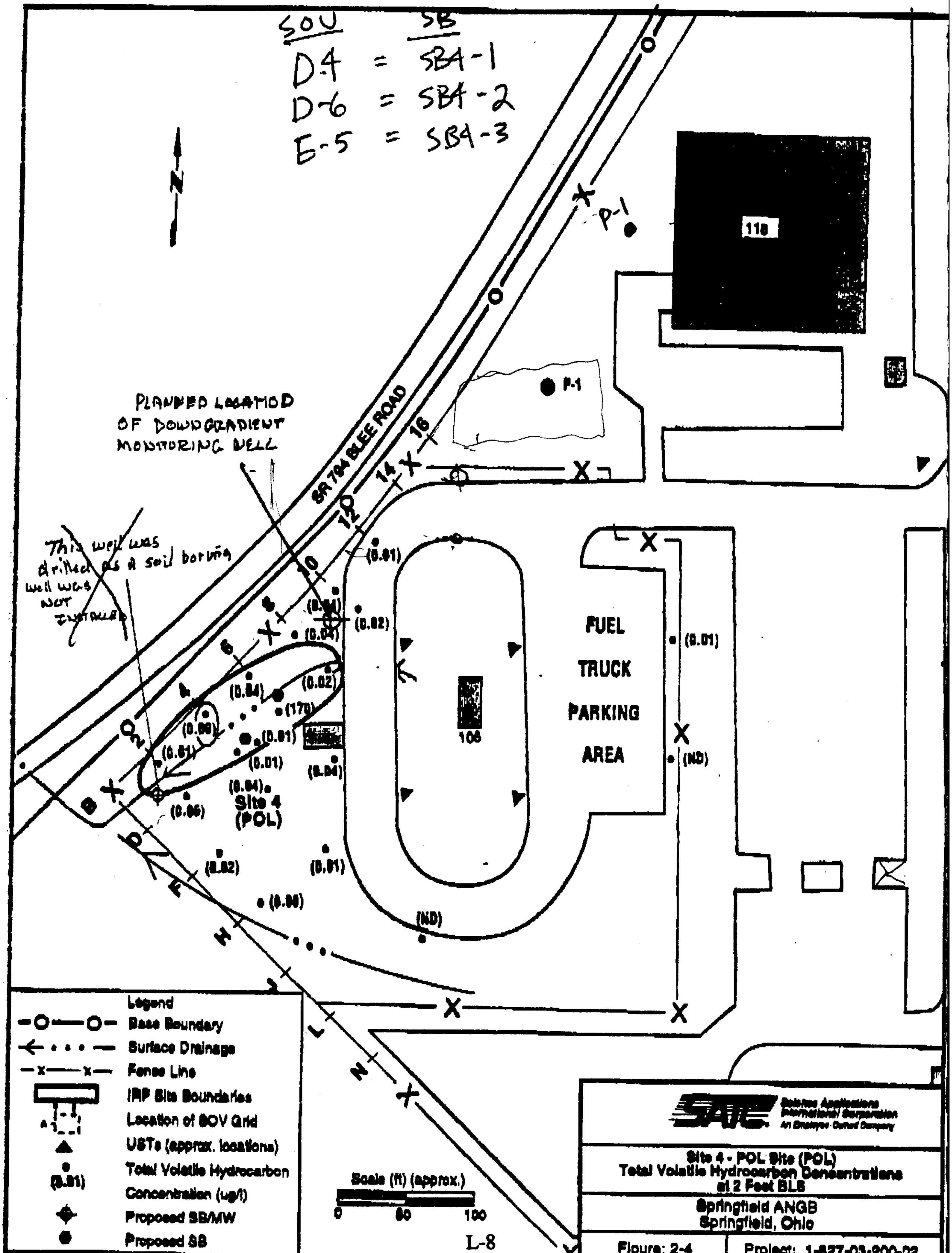

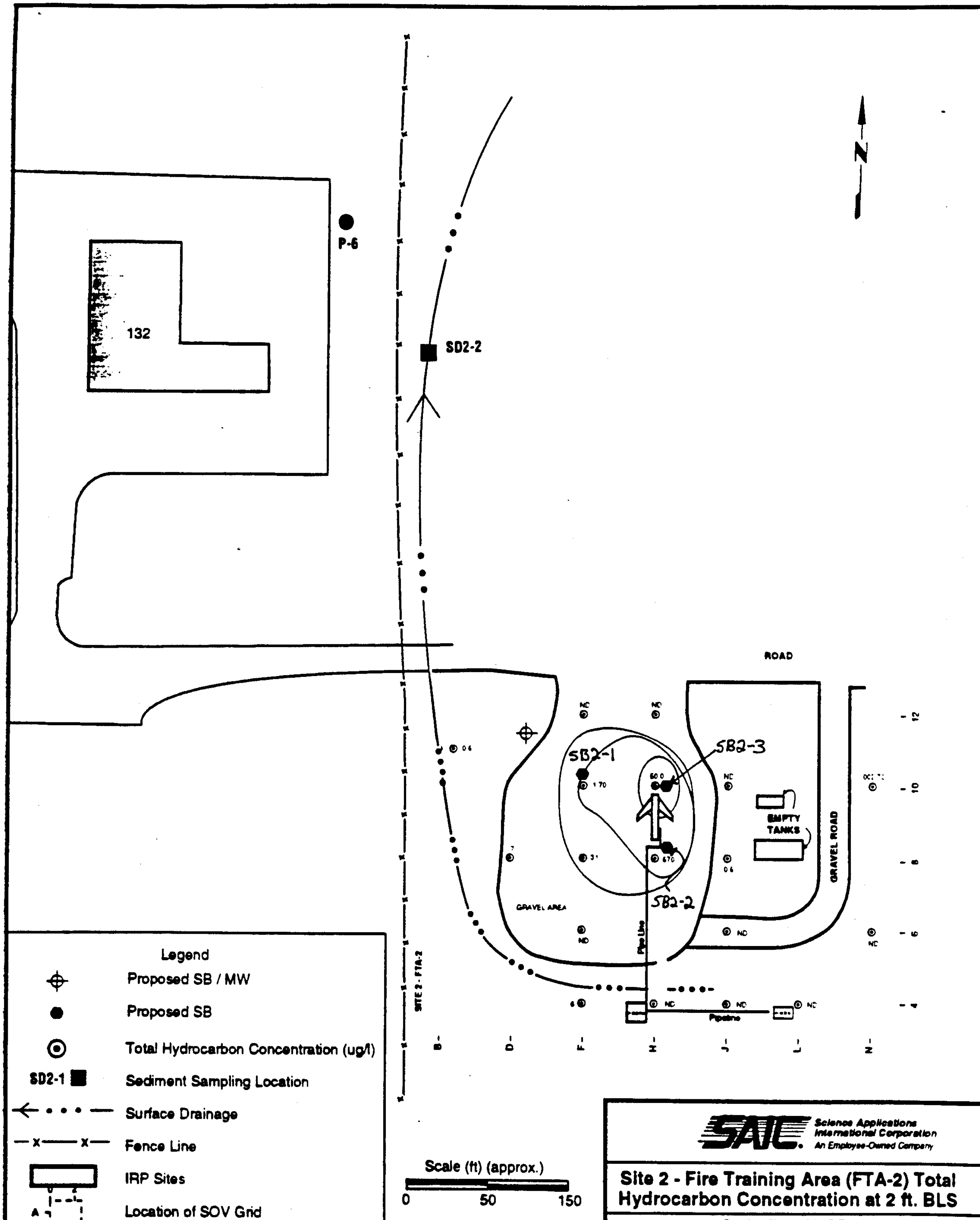

Legend

- Proposed SB / MW
- Proposed SB
- Total Hydrocarbon Concentration (ug/l)
- SD2-1 Sediment Sampling Location
- Surface Drainage
- Fence Line
- IRP Sites
- Location of SOV Grid
- 200 Total Volatile Hydrocarbon Concentration (ug/l)

Scale (ft) (approx.)
0 50 150

SAIC Science Applications International Corporation
An Employee-Owned Company

Site 2 - Fire Training Area (FTA-2) Total Hydrocarbon Concentration at 2 ft. BLS

Springfield ANGB
Springfield, Ohio

Figure: 2-2 | Project: 1-827-03-200-02

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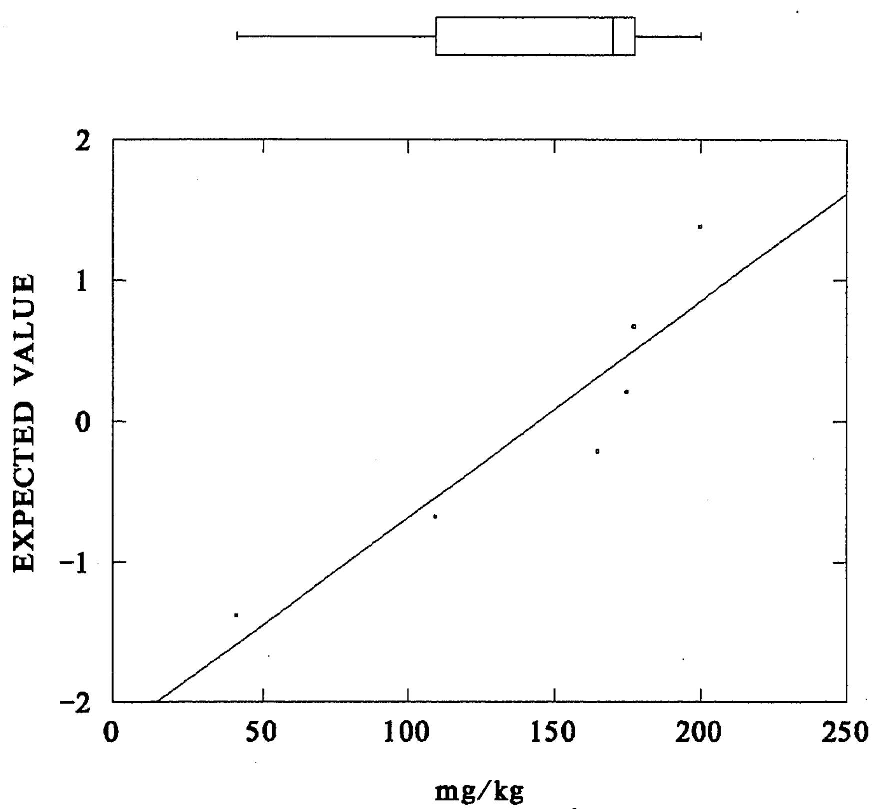
APPENDIX M

Goodness-of-Fit Test Results

Figure M-1. Goodness-of-Fit Tests Using Probability and Box Plots: Acenaphthylene in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



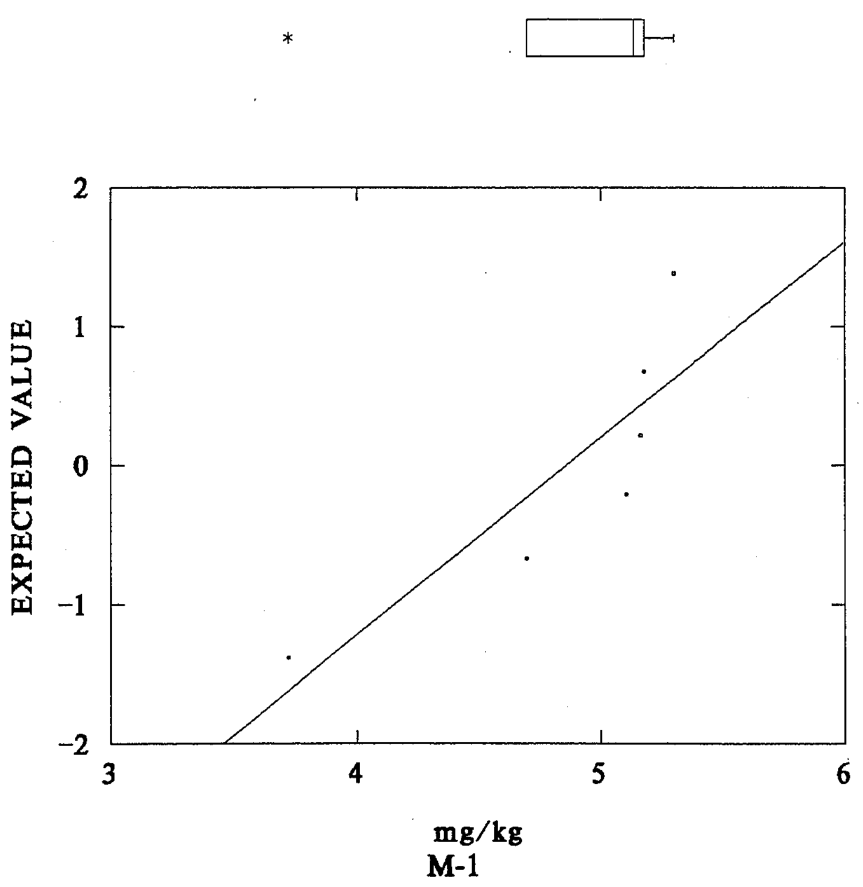
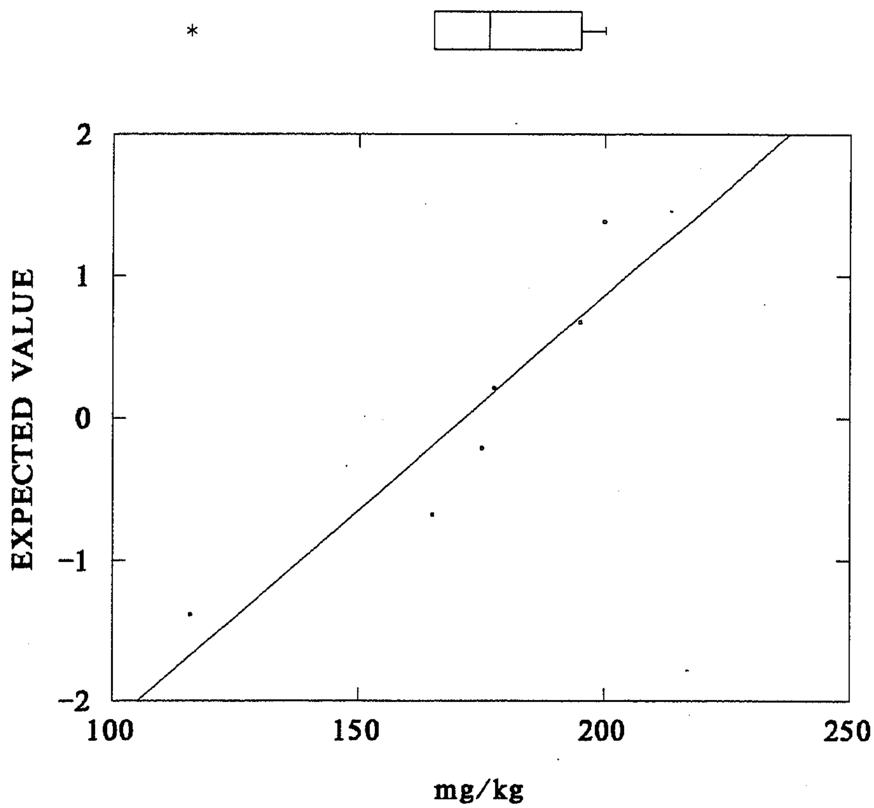


Figure M-2. Goodness-of-Fit Tests Using Probability and Box Plots: Anthracene in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



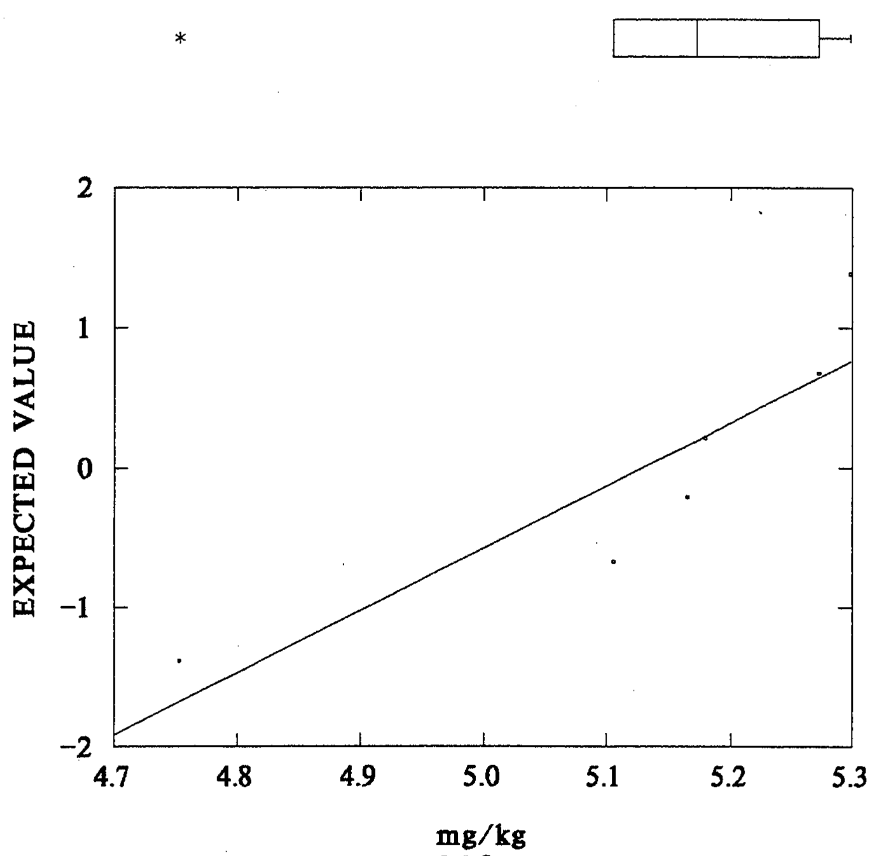
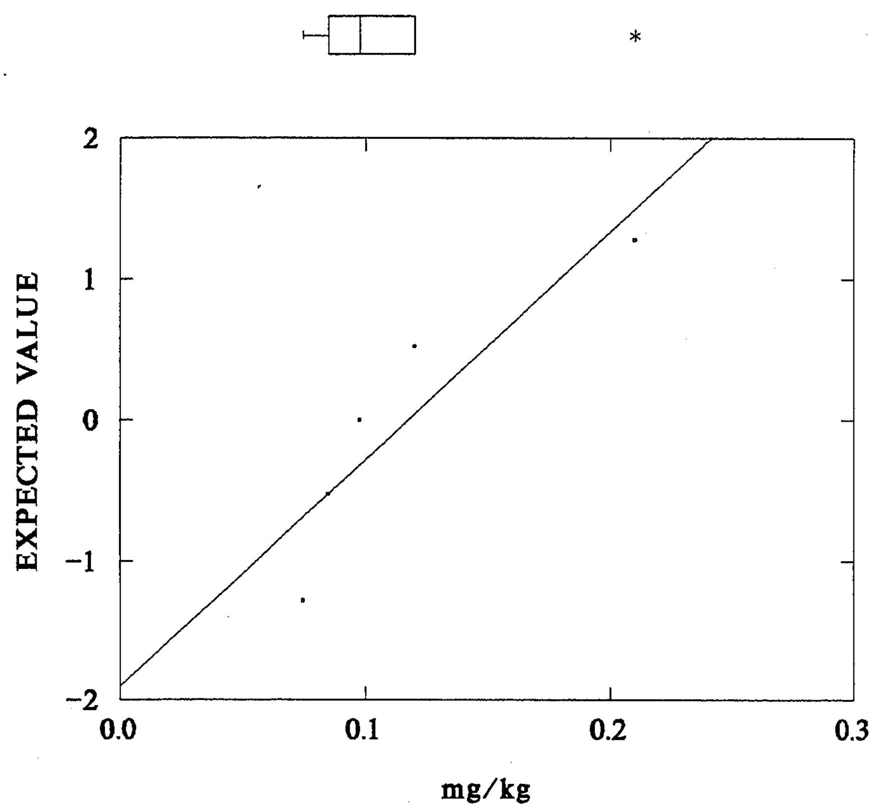


Figure M-3. Goodness-of-Fit Tests Using Probability and Box Plots: Antimony in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



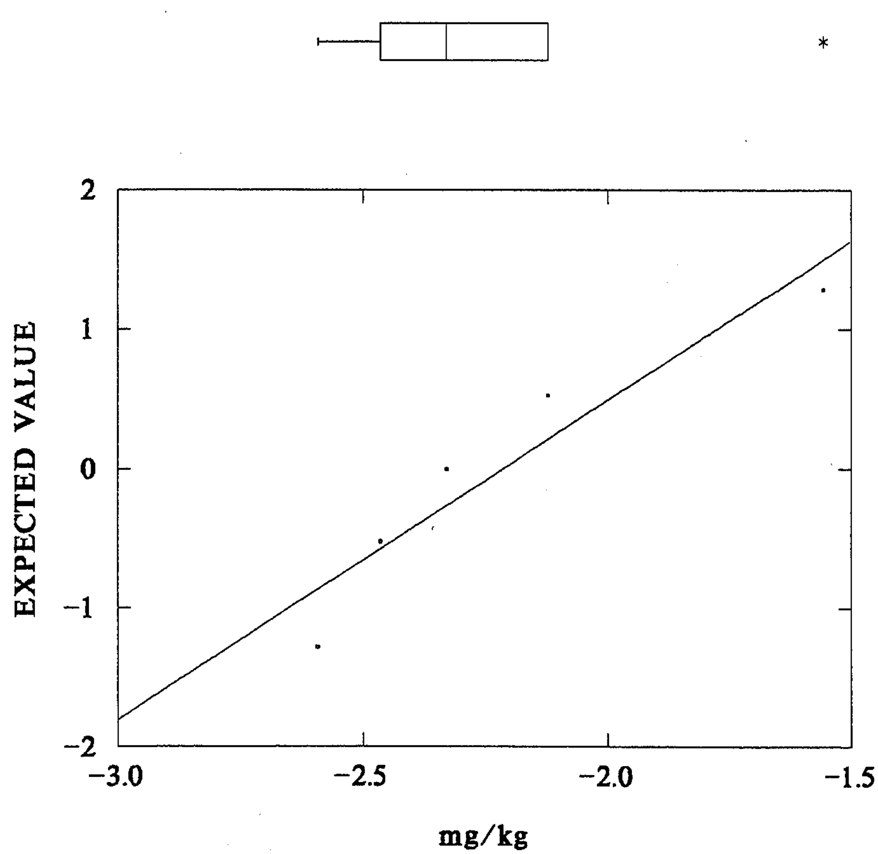
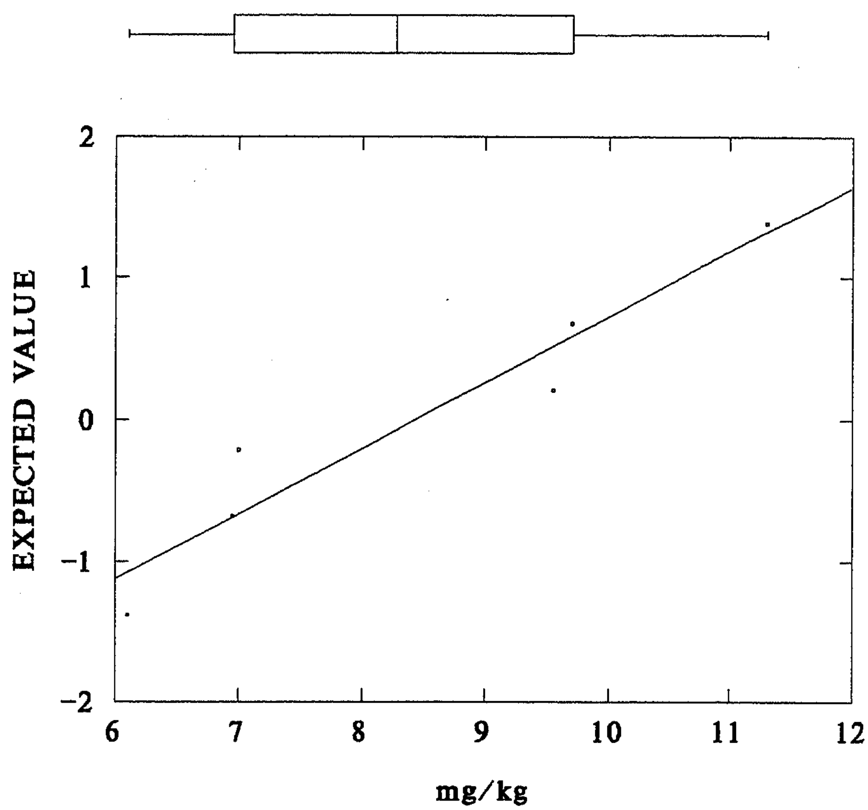


Figure M-4. Goodness-of-Fit Tests Using Probability and Box Plots: Arsenic in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



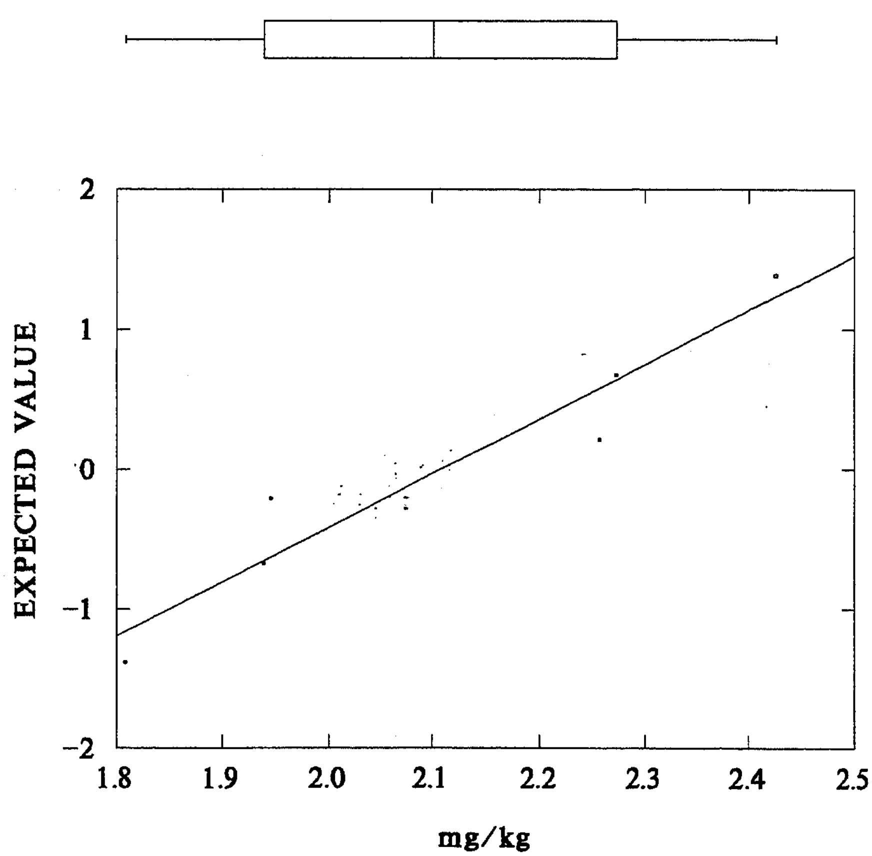
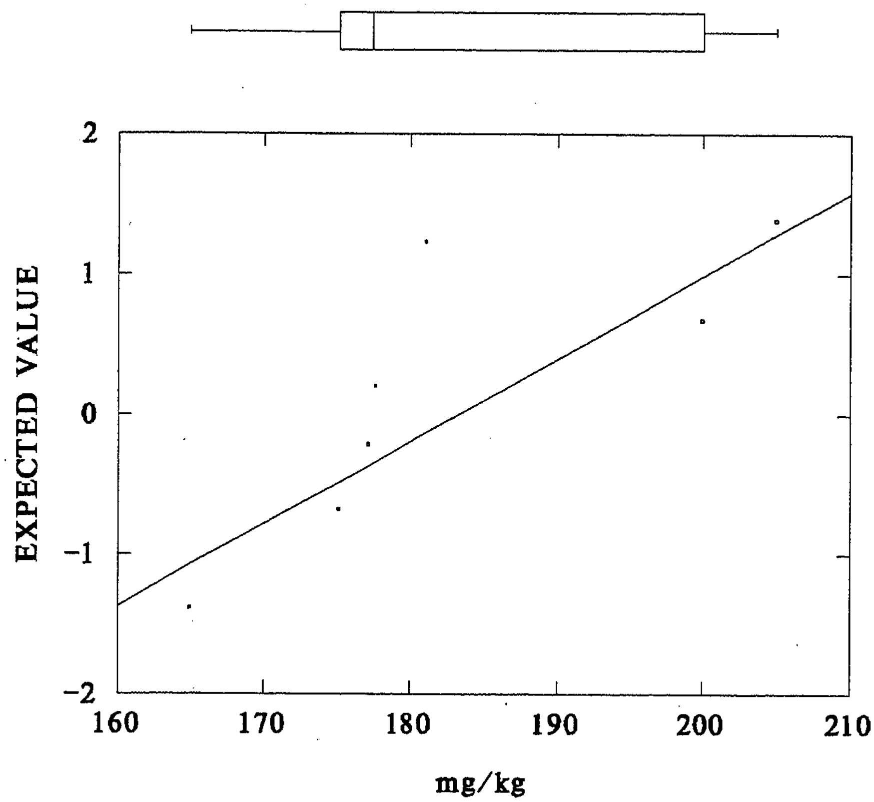


Figure M-5. Goodness-of-Fit Tests Using Probability and Box Plots: Benzo(a)anthracene in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



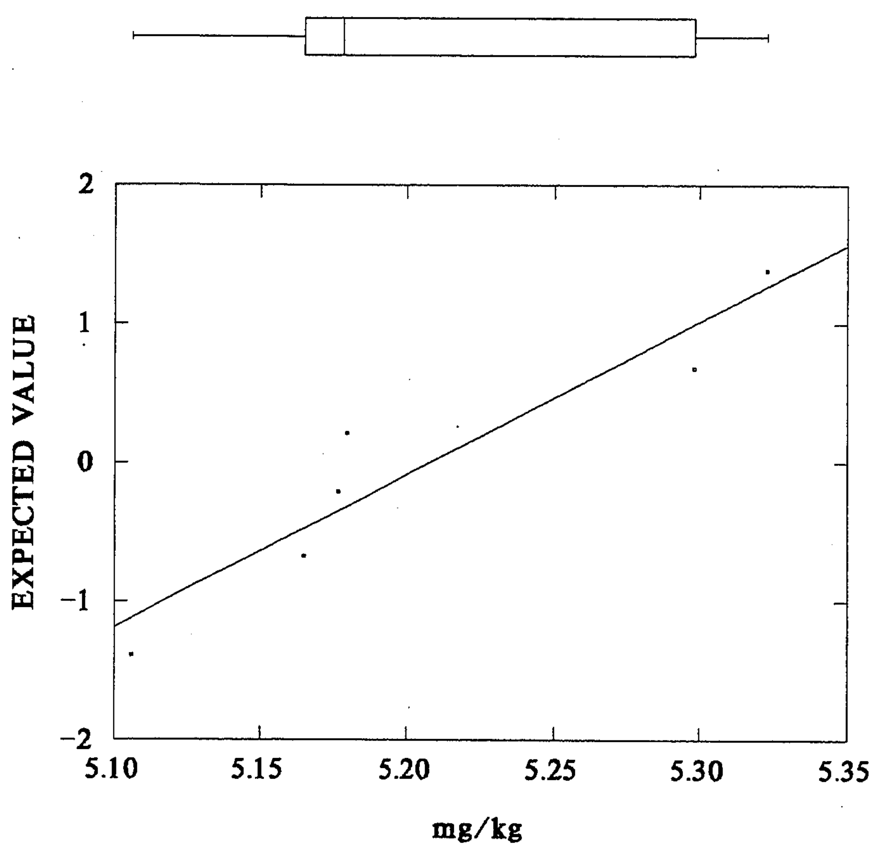
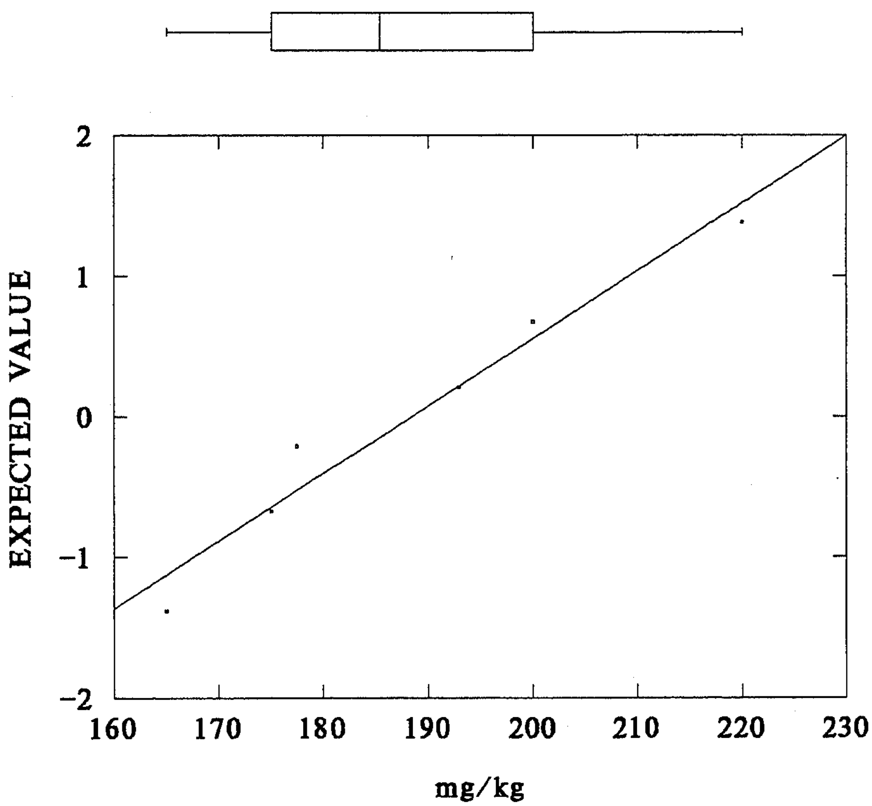


Figure M-6. Goodness-of-Fit Tests Using Probability and Box Plots: Benzo(a)pyrene in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



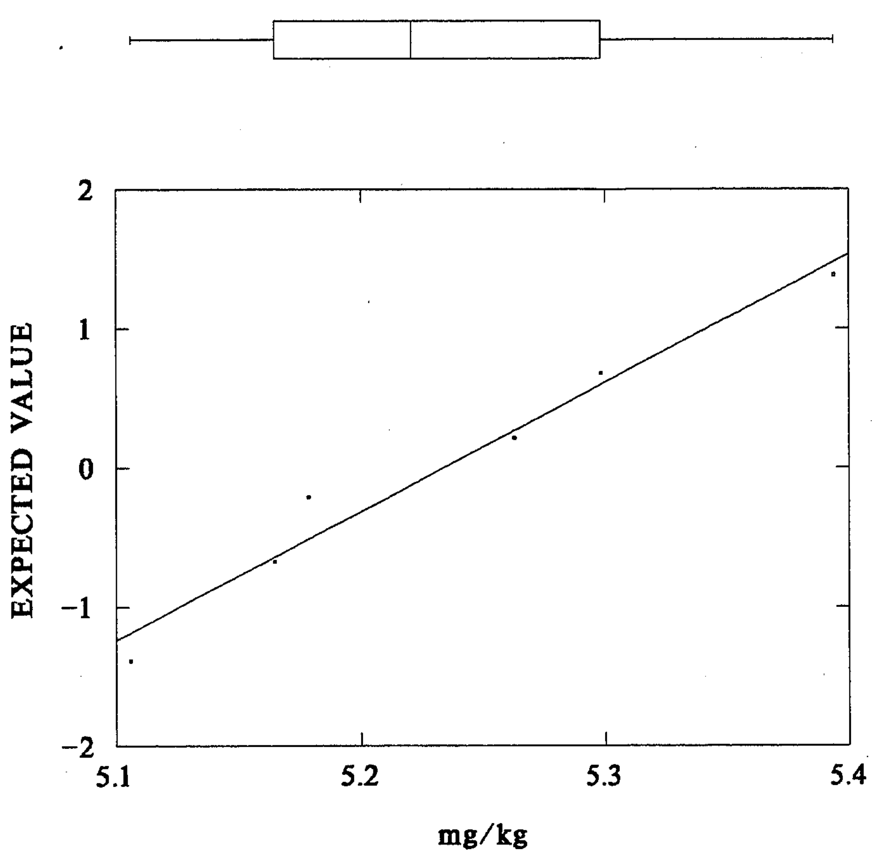
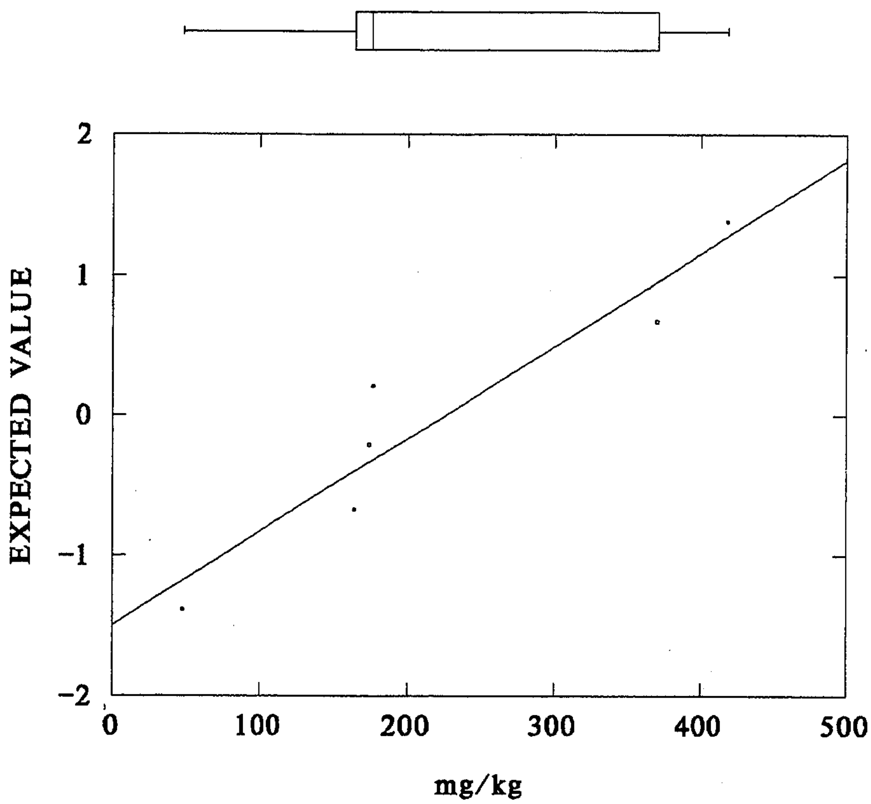


Figure M-7. Goodness-of-Fit Tests Using Probability and Box Plots: Benzo(b)fluoranthene in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



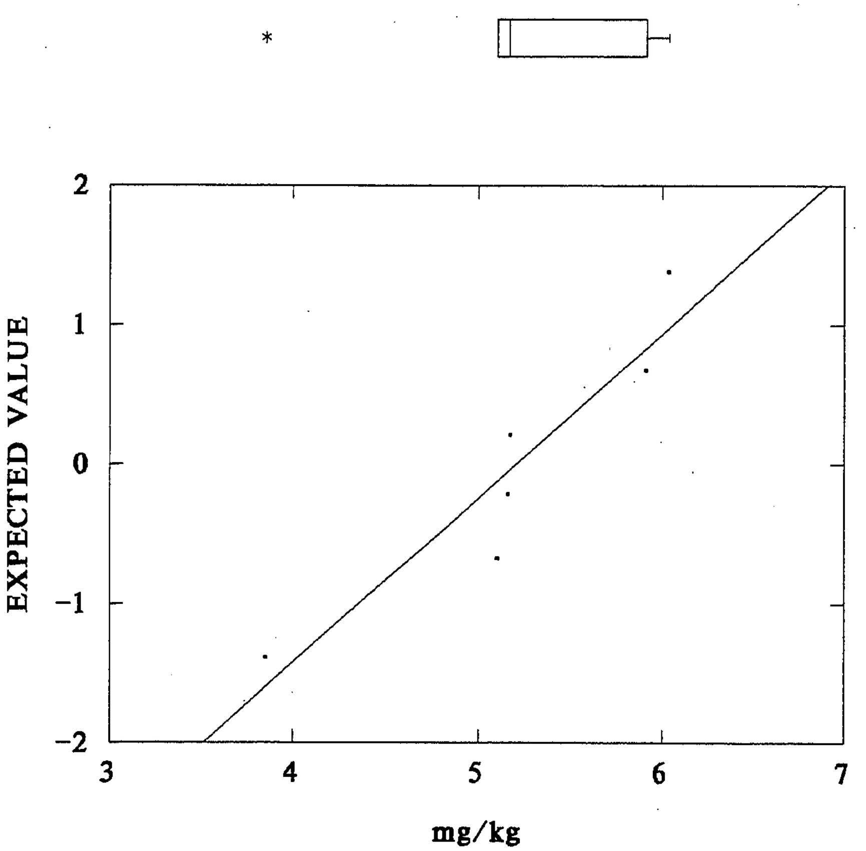
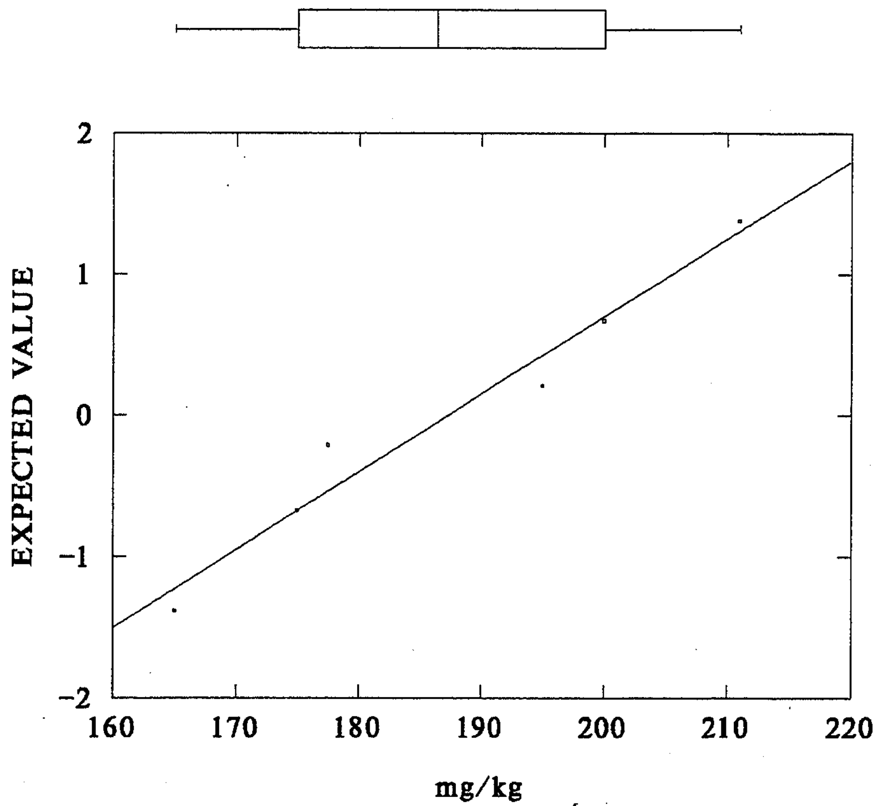


Figure M-8. Goodness-of-Fit Tests Using Probability and Box Plots: Benzo(g,h,i)perylene in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



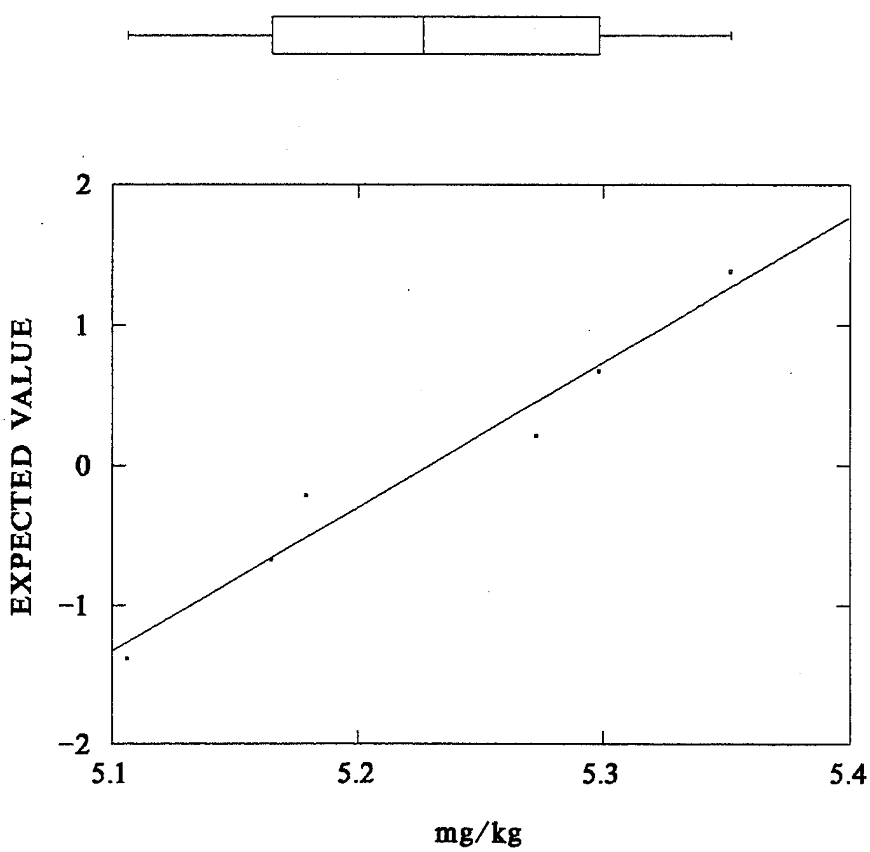
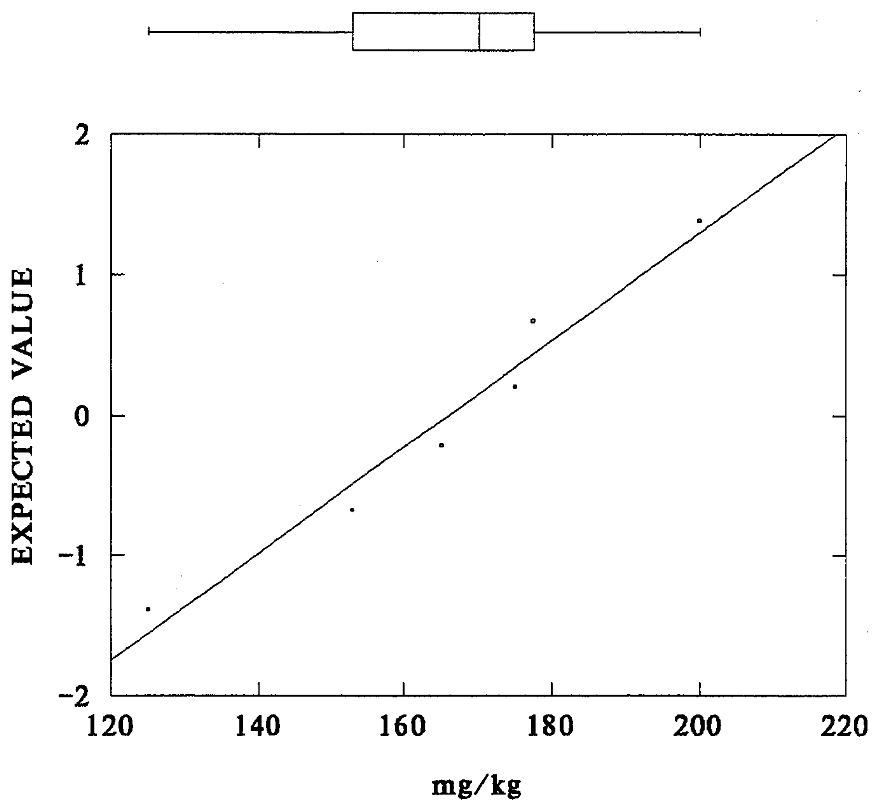


Figure M-9. Goodness-of-Fit Tests Using Probability and Box Plots: Benzo(k)fluoranthene in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



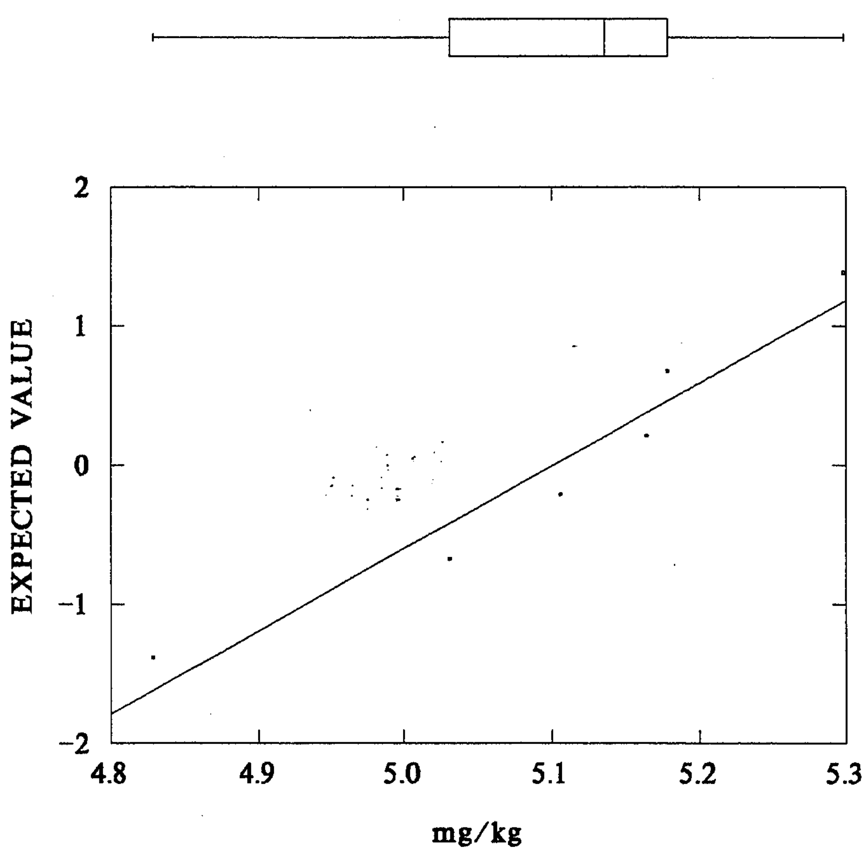
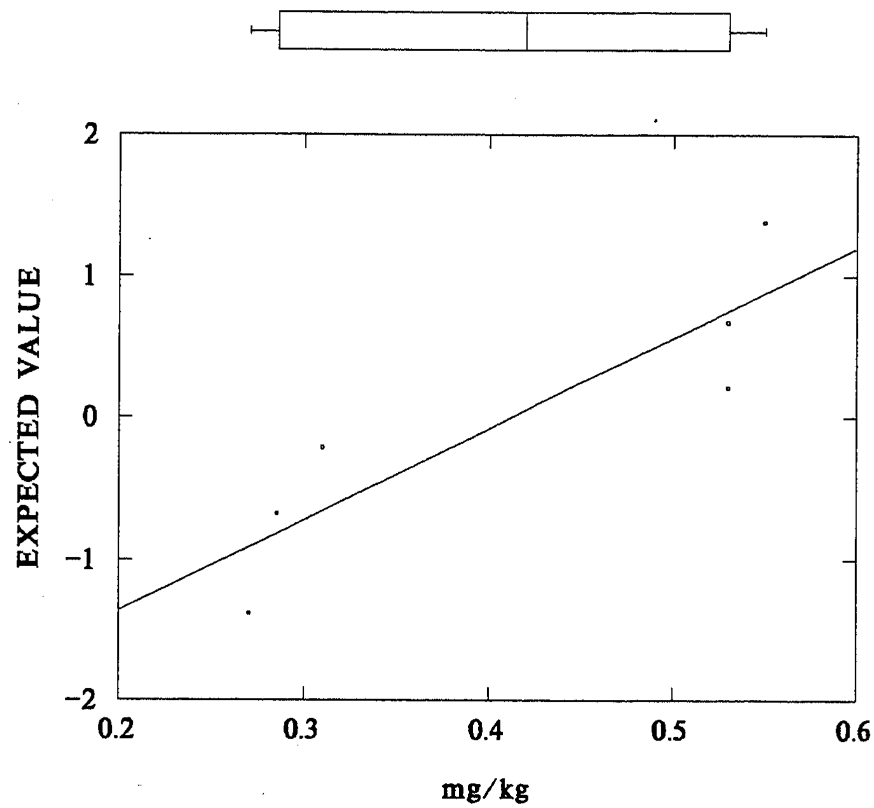


Figure M-10. Goodness-of-Fit Tests Using Probability and Box Plots: Beryllium in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



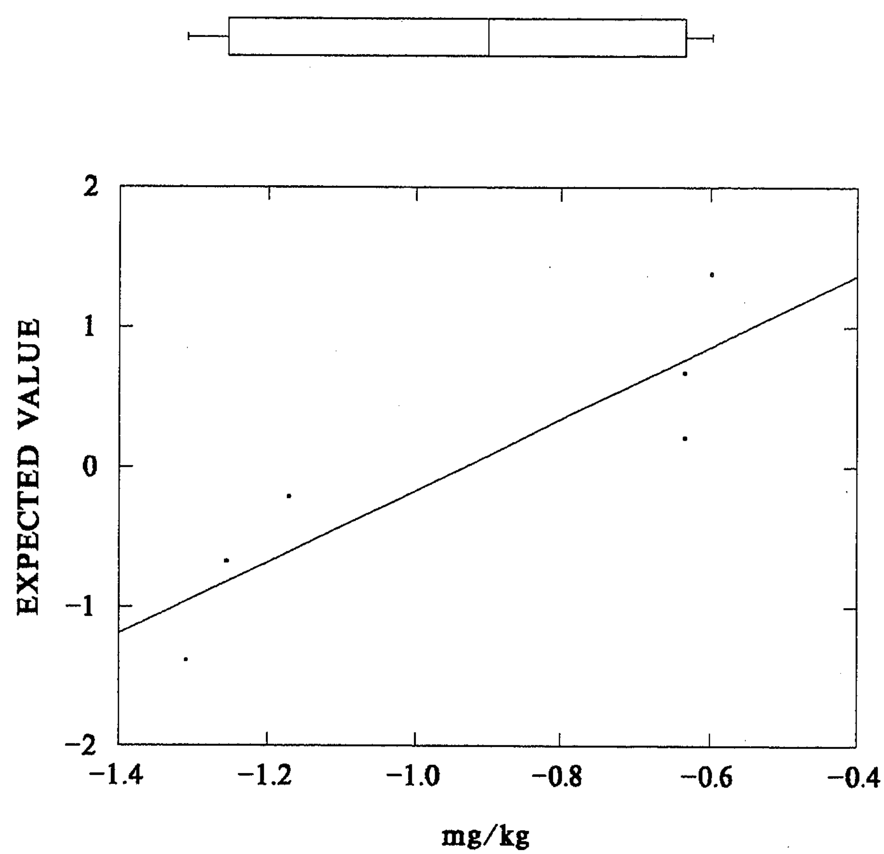
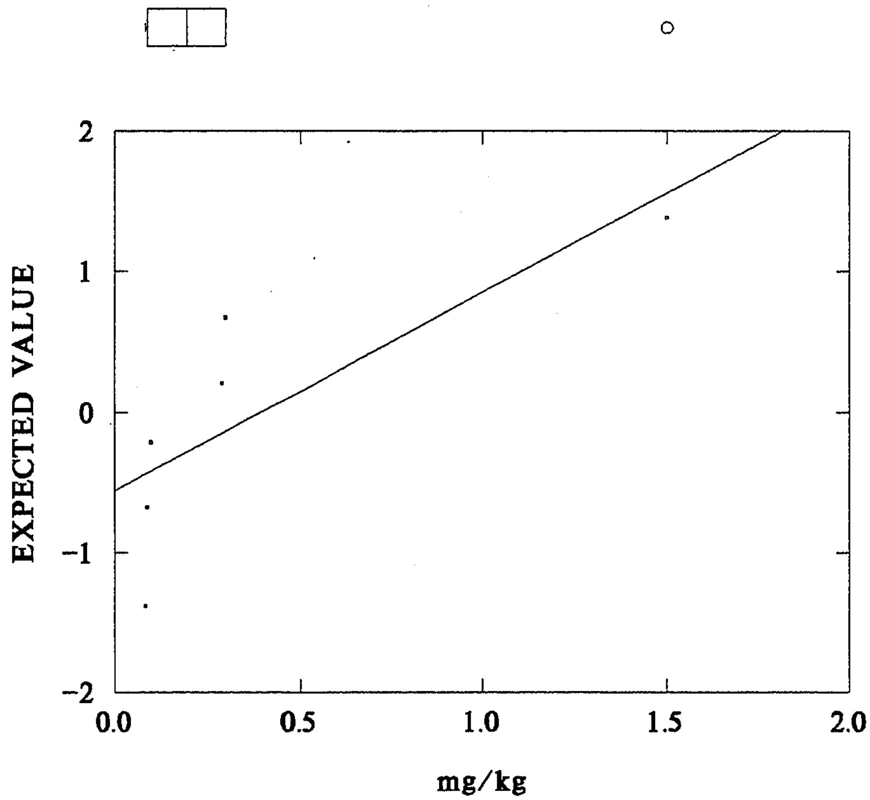


Figure M-11. Goodness-of-Fit Tests Using Probability and Box Plots: Cadmium in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



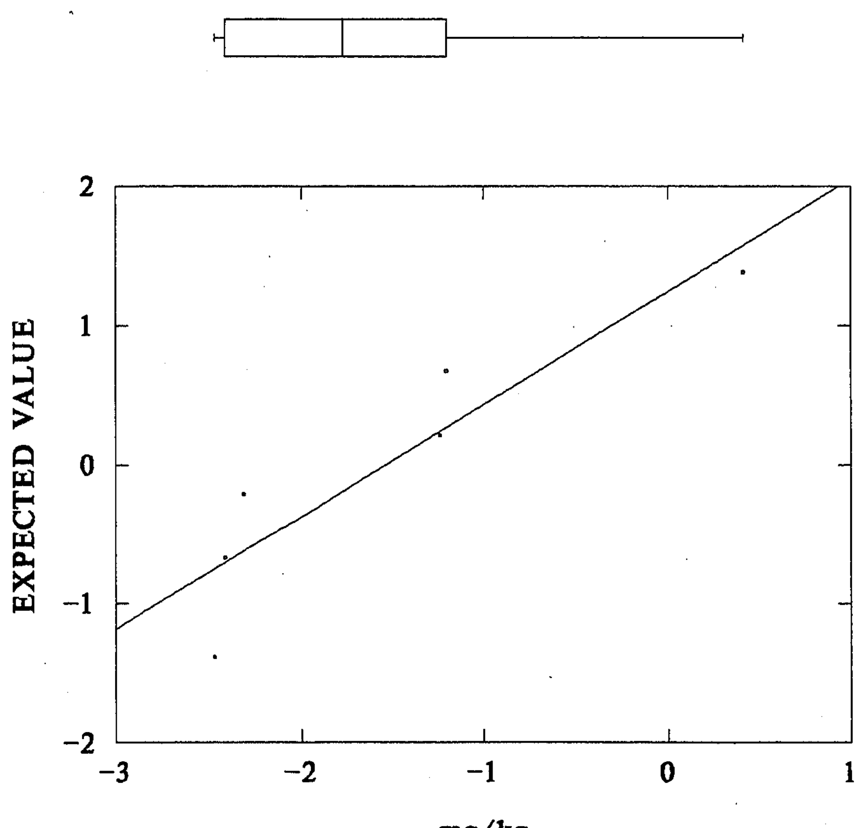
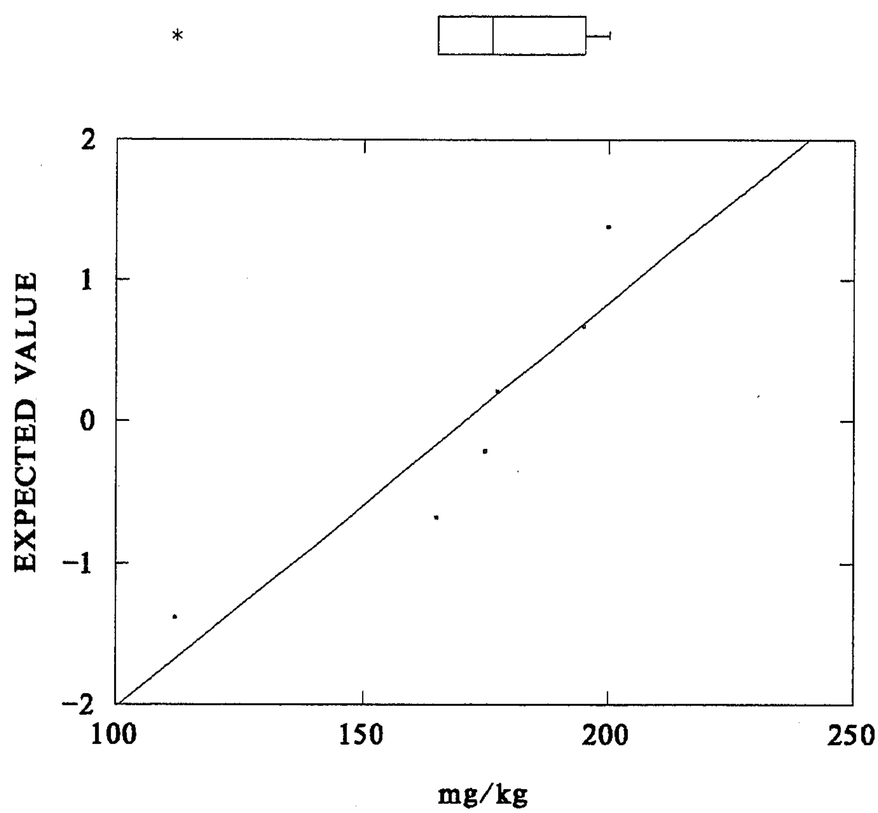


Figure M-12. Goodness-of-Fit Tests Using Probability and Box Plots: Carbazole in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



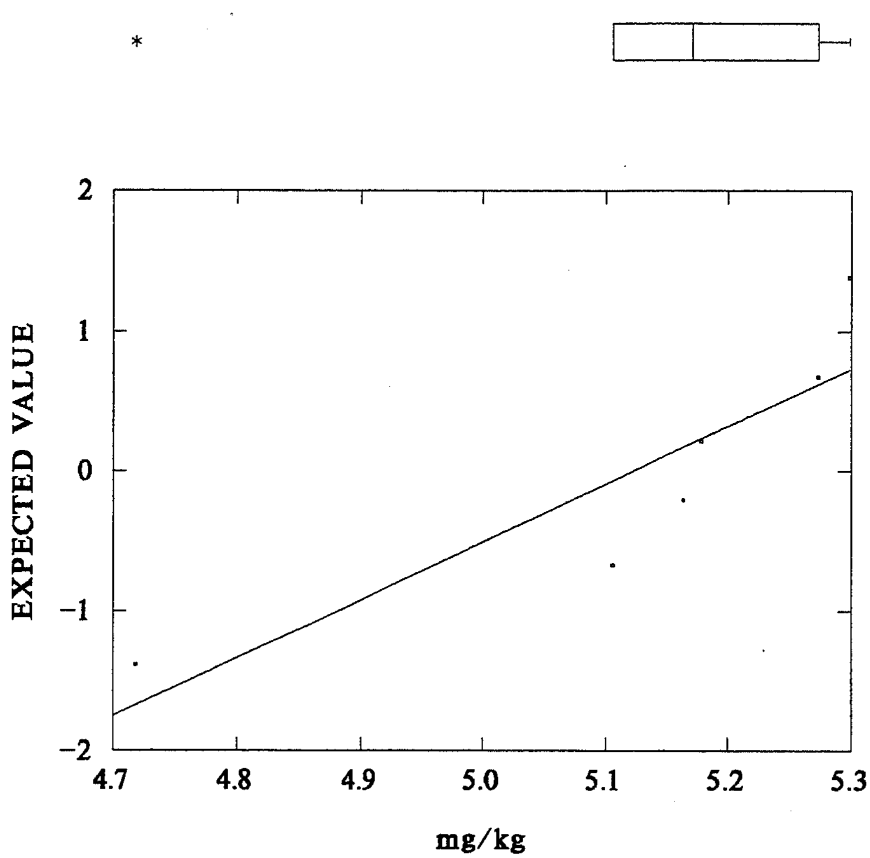
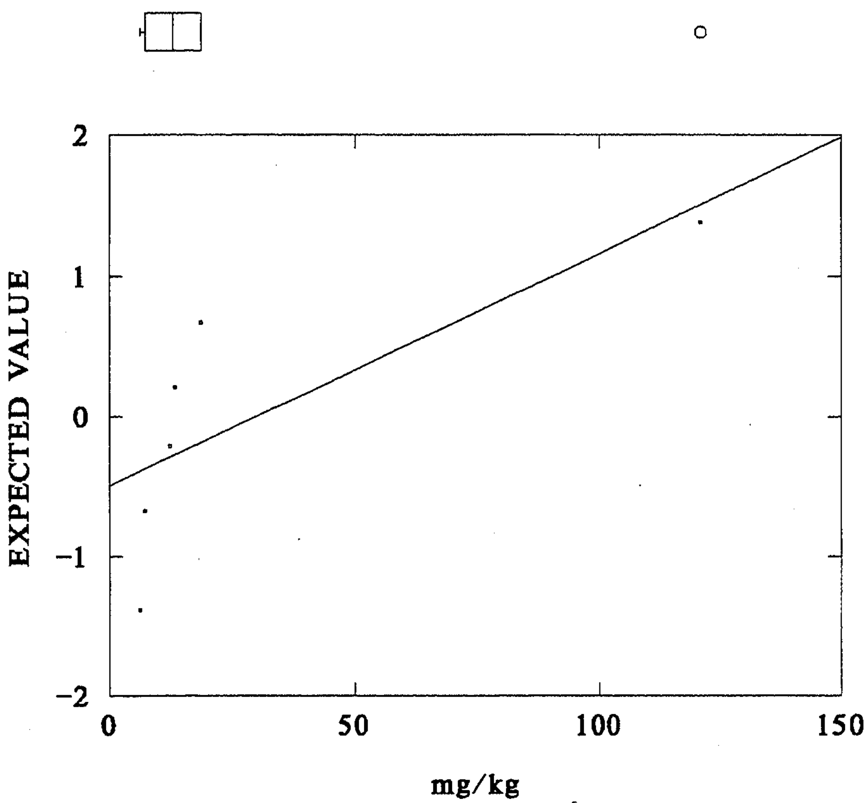


Figure M-13. Goodness-of-Fit Tests Using Probability and Box Plots: Chromium in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



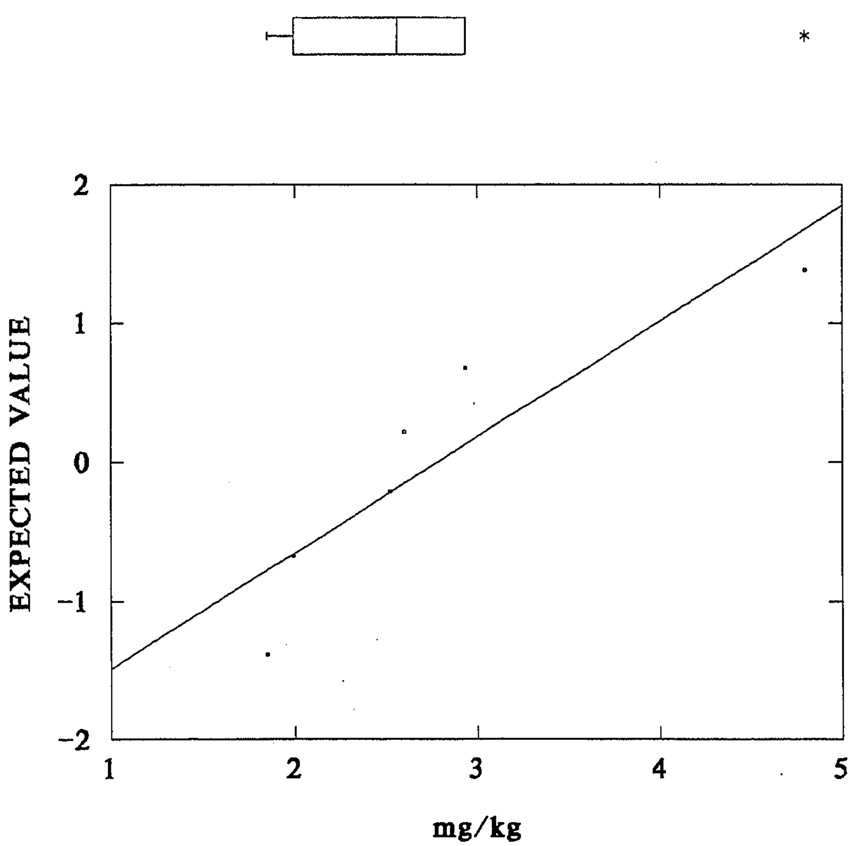
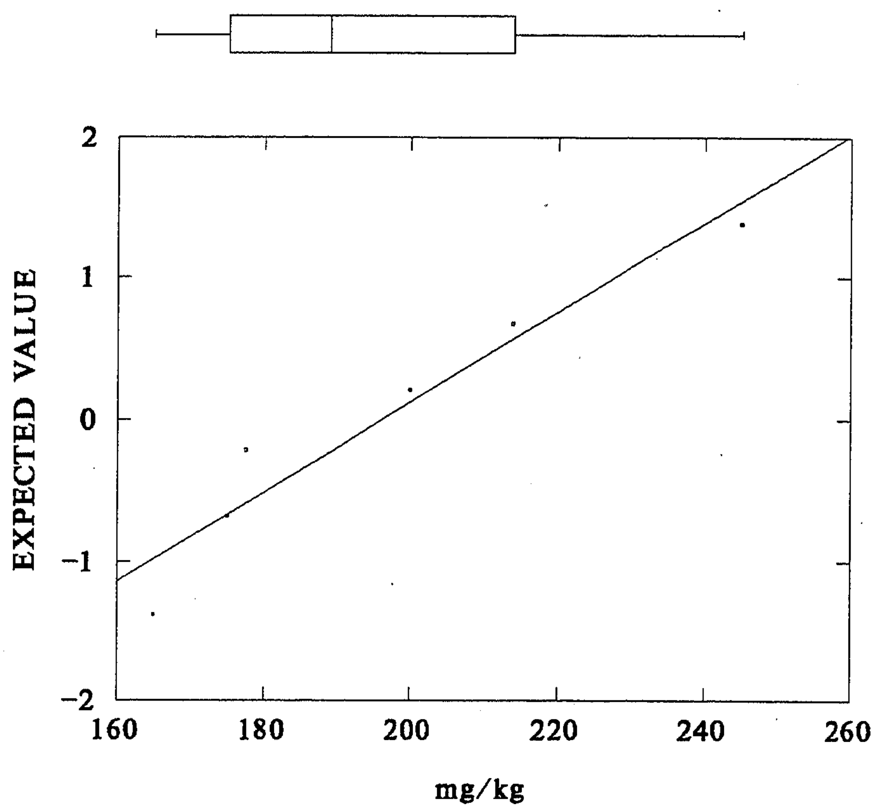


Figure M-14. Goodness-of-Fit Tests Using Probability and Box Plots: Chrysene in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



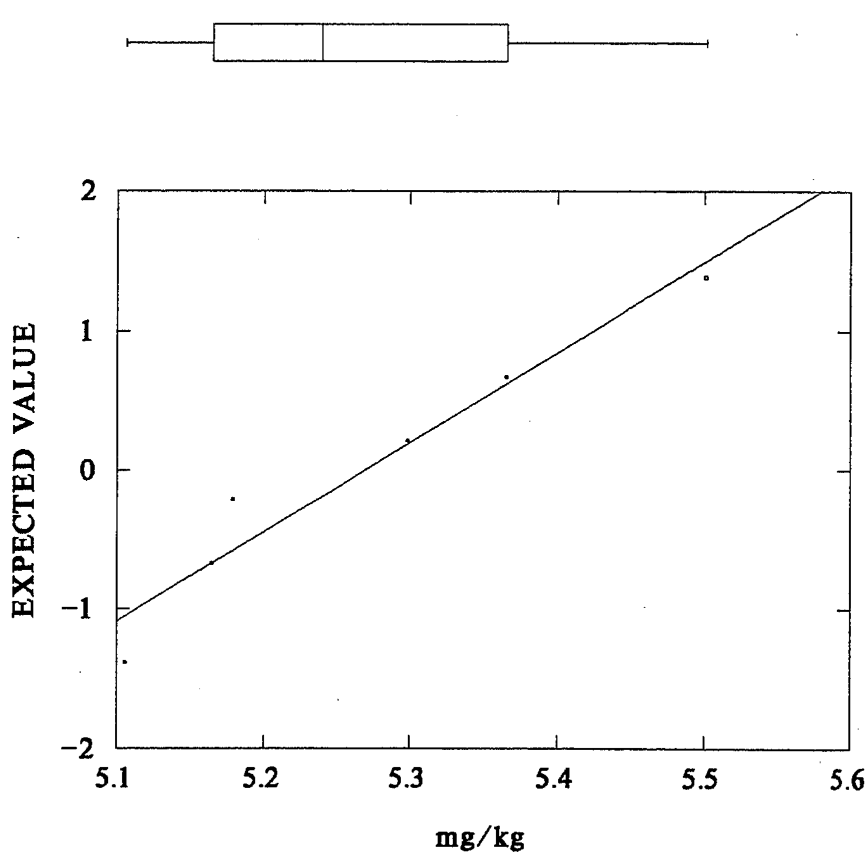
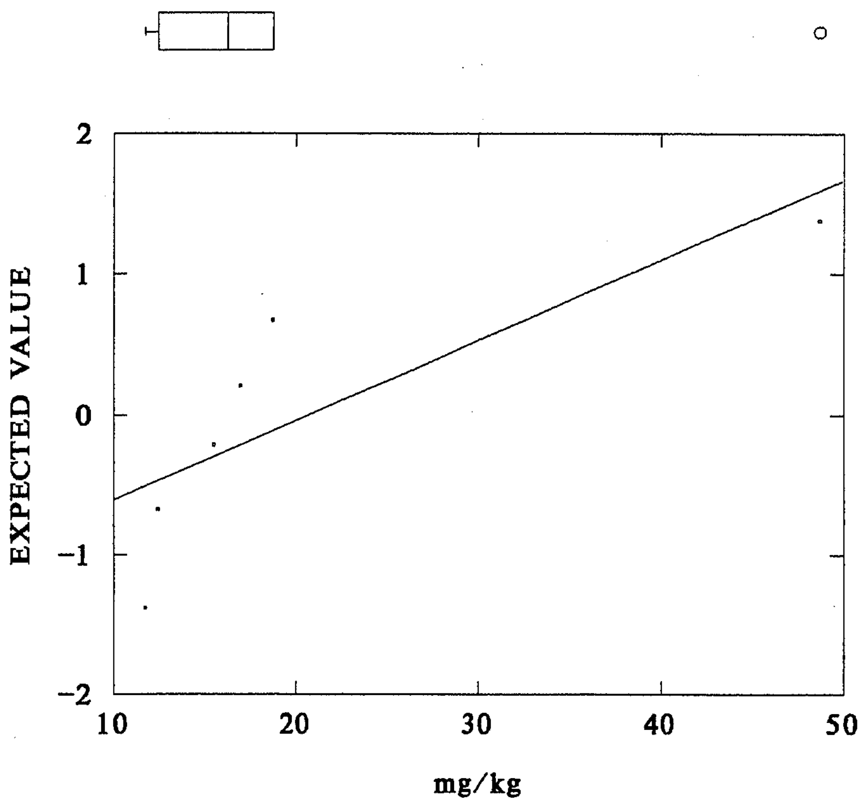


Figure M-15. Goodness-of-Fit Tests Using Probability and Box Plots: Copper in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



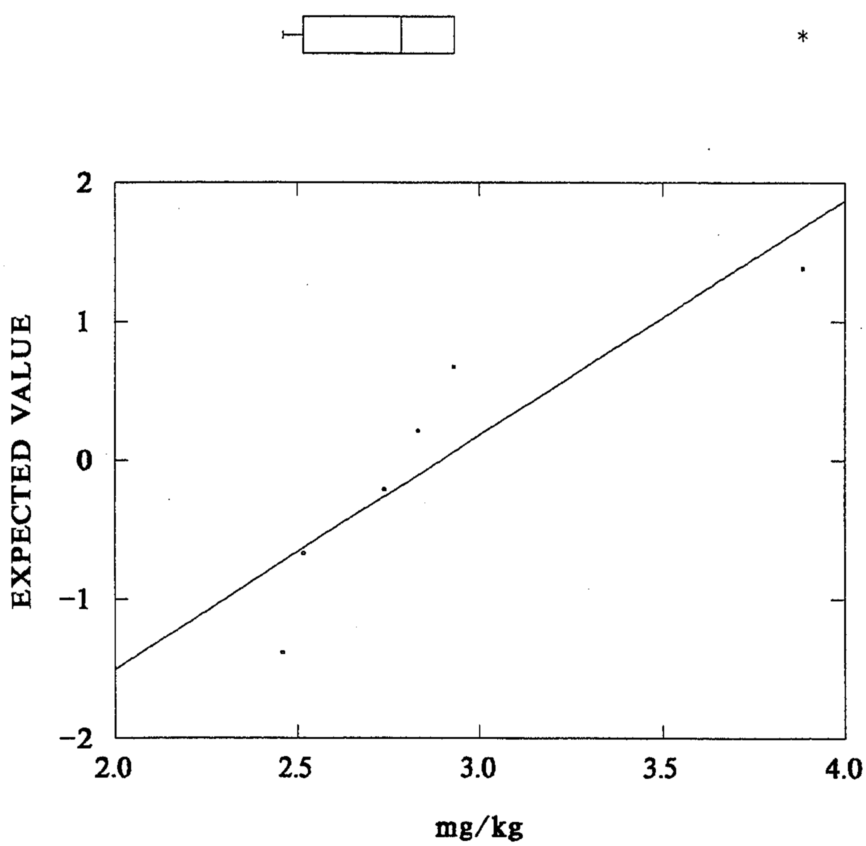
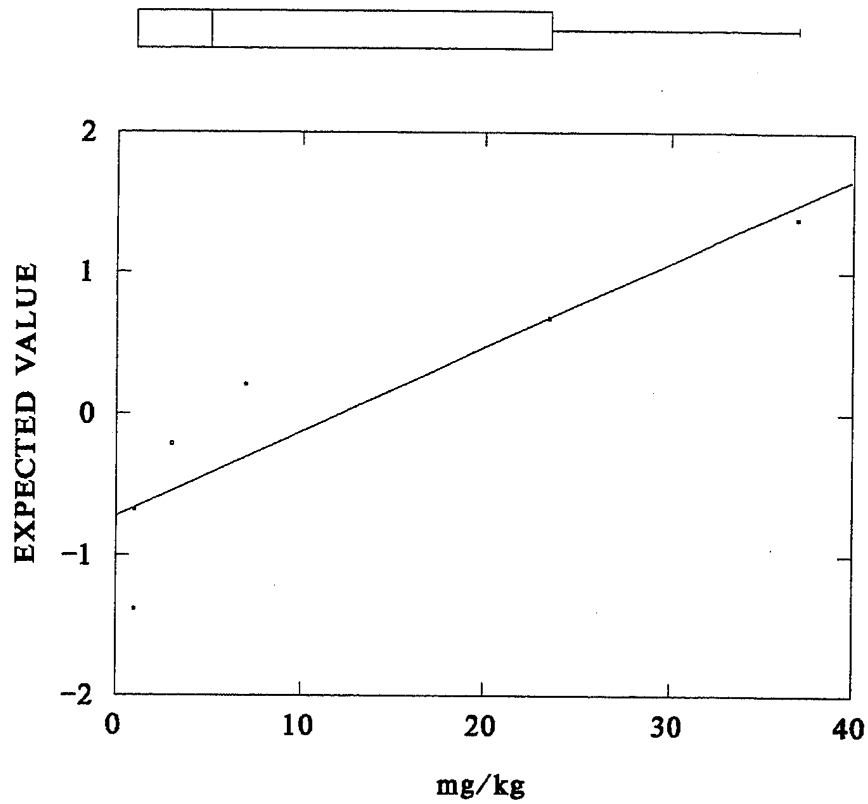


Figure M-16. Goodness-of-Fit Tests Using Probability and Box Plots: Diesel Fuel in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



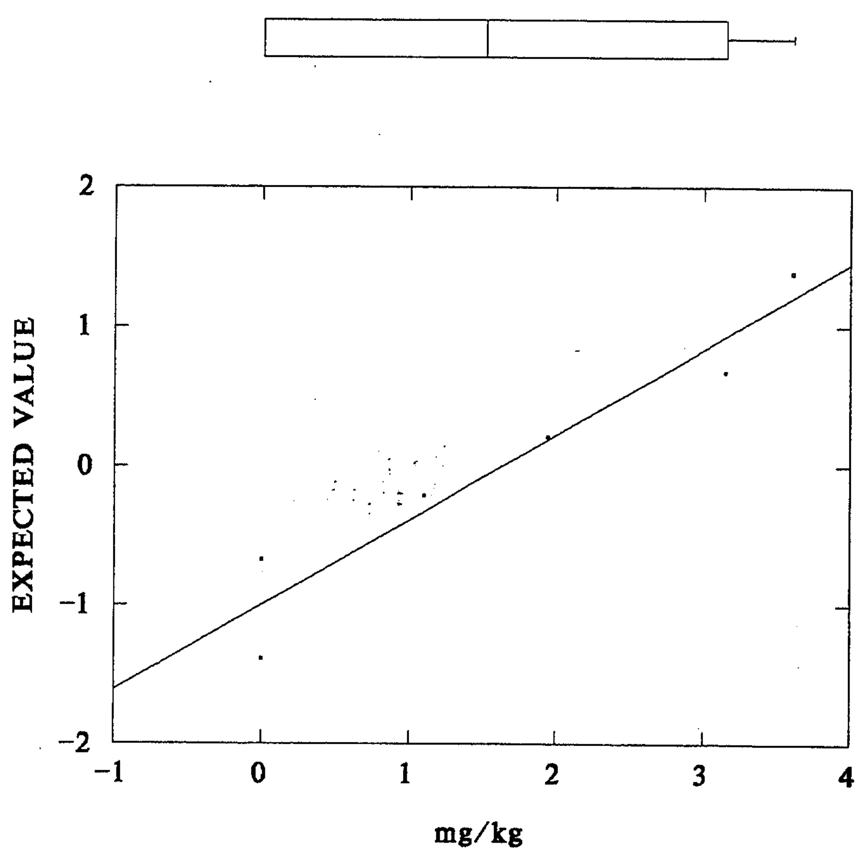
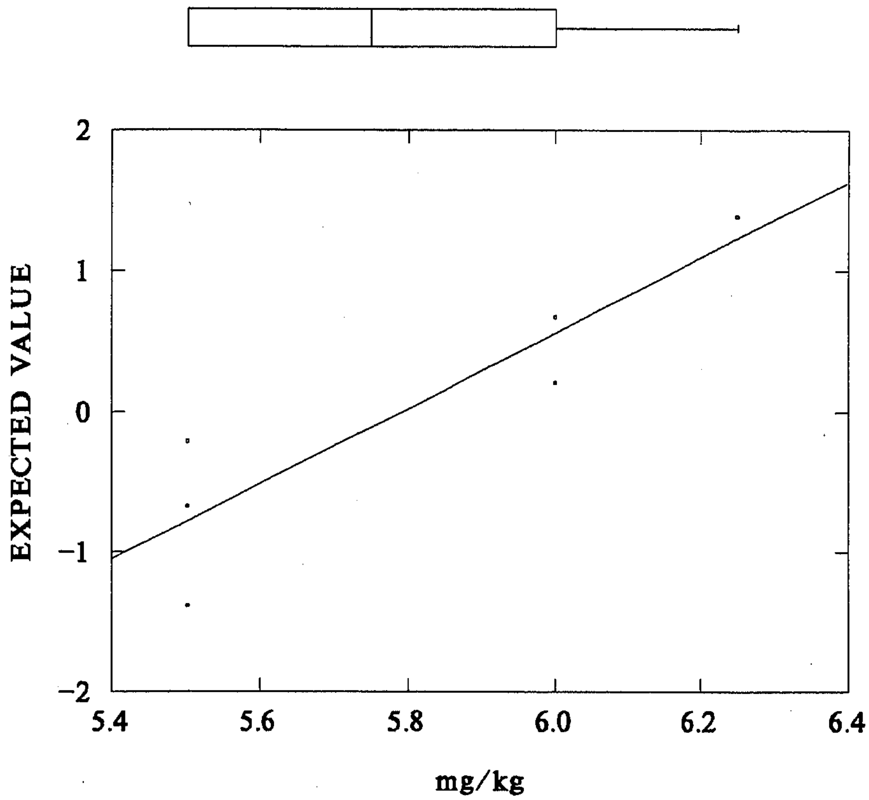


Figure M-17. Goodness-of-Fit Tests Using Probability and Box Plots: Ethylbenzene in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



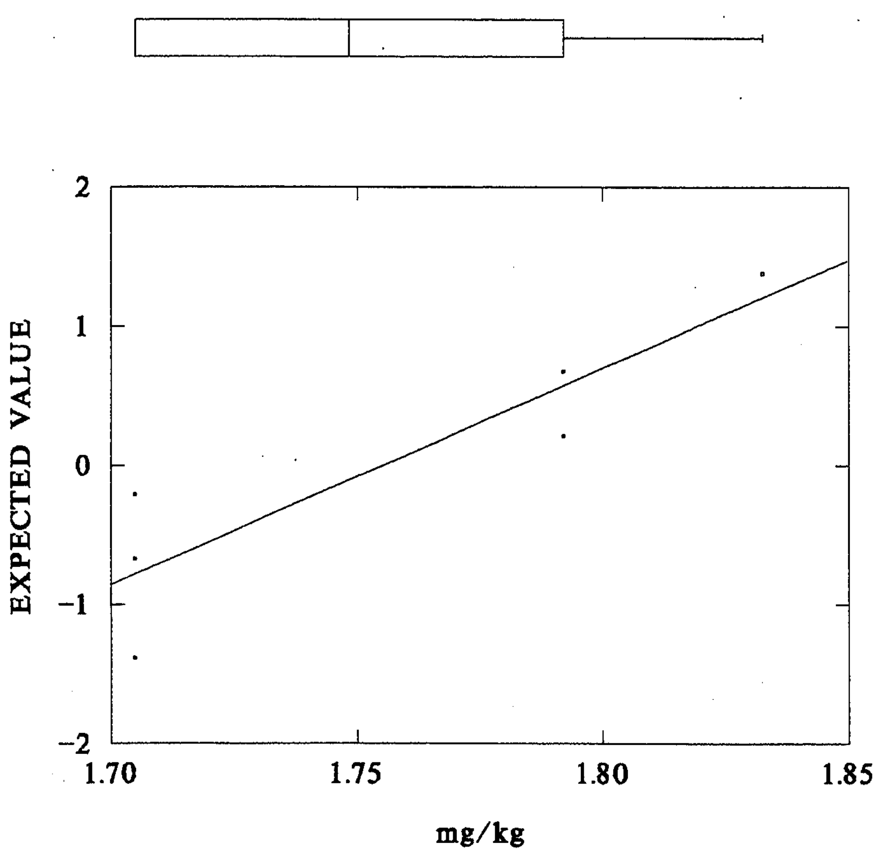
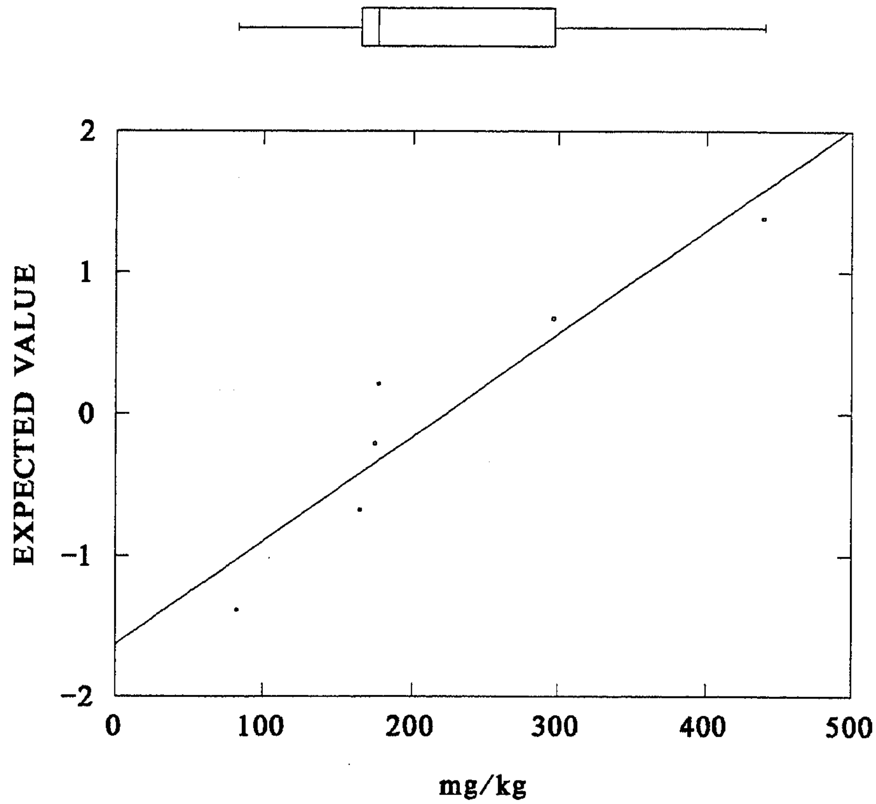


Figure M-18. Goodness-of-Fit Tests Using Probability and Box Plots: Fluoranthene in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



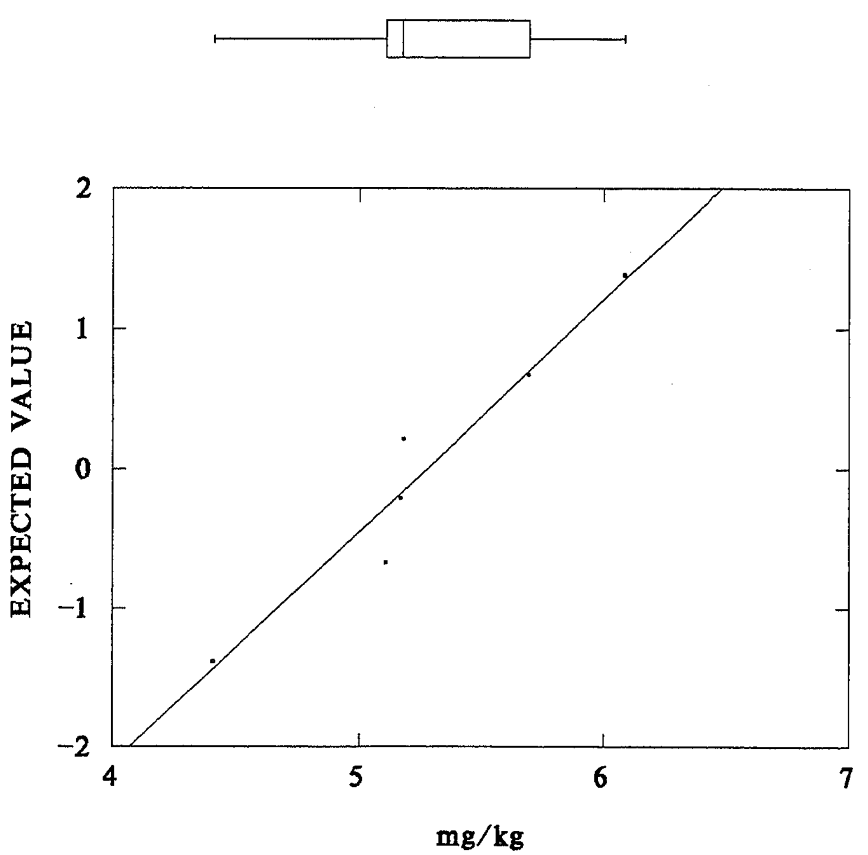
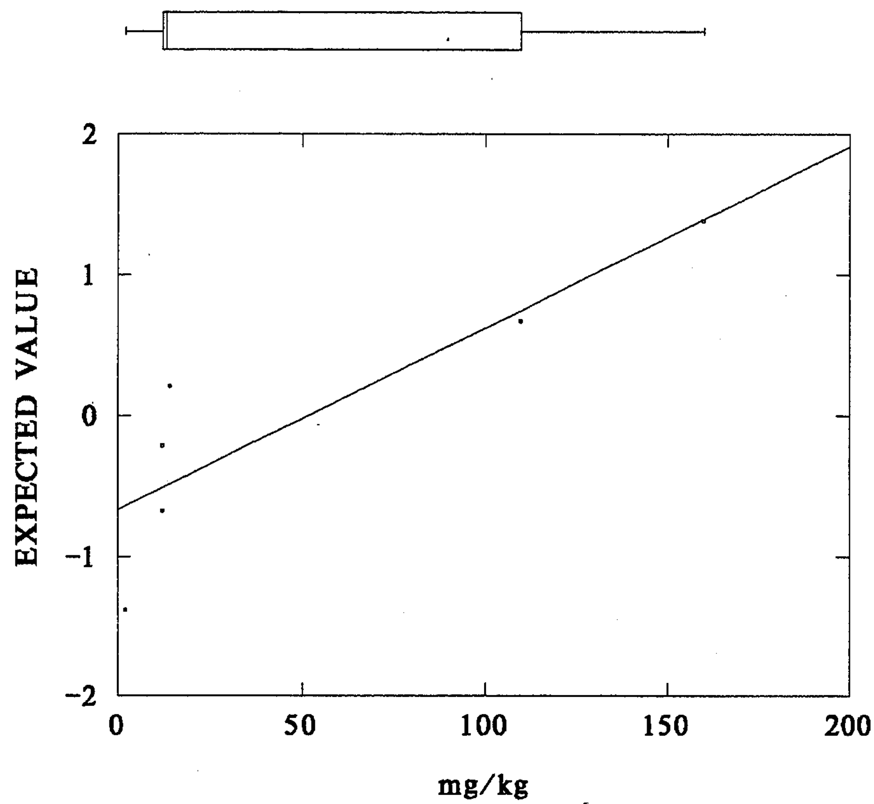


Figure M-19. Goodness-of-Fit Tests Using Probability and Box Plots: Heavy Oil in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



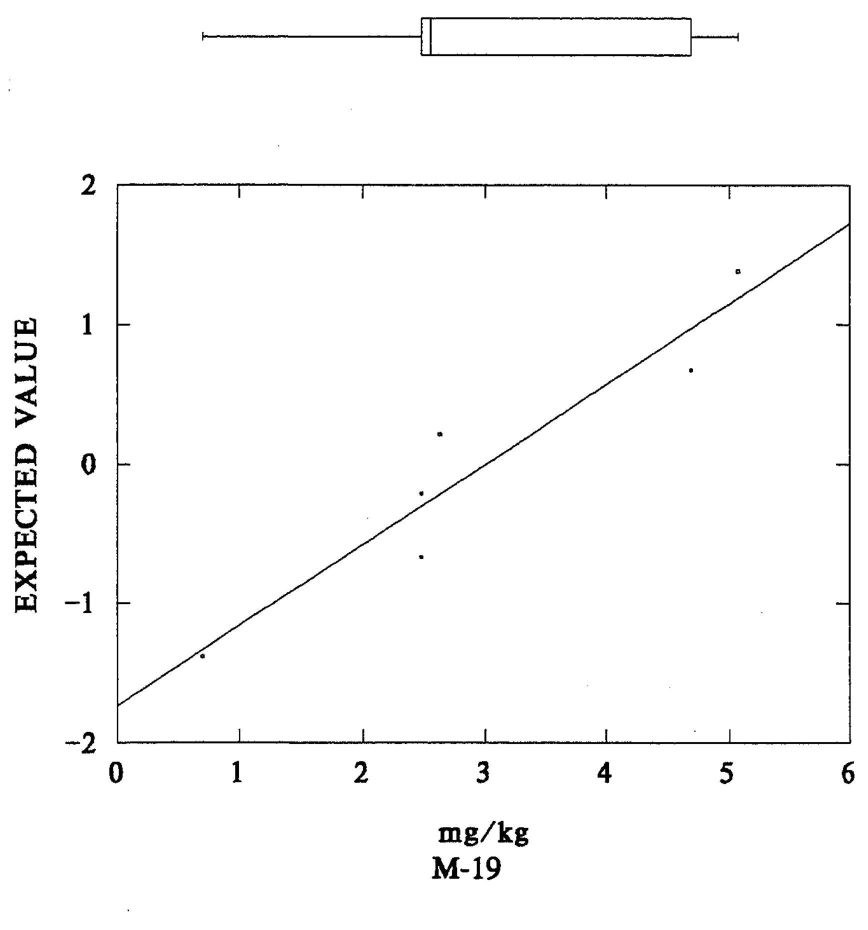
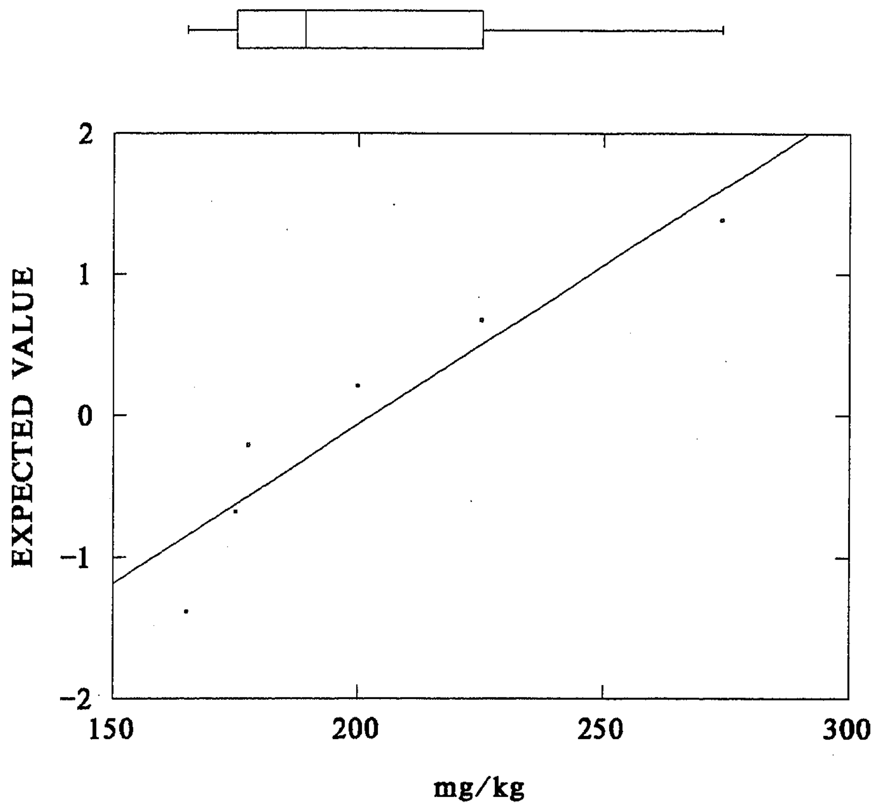


Figure M-20. Goodness-of-Fit Tests Using Probability and Box Plots: Indeno(1,2,3-cd)pyrene in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



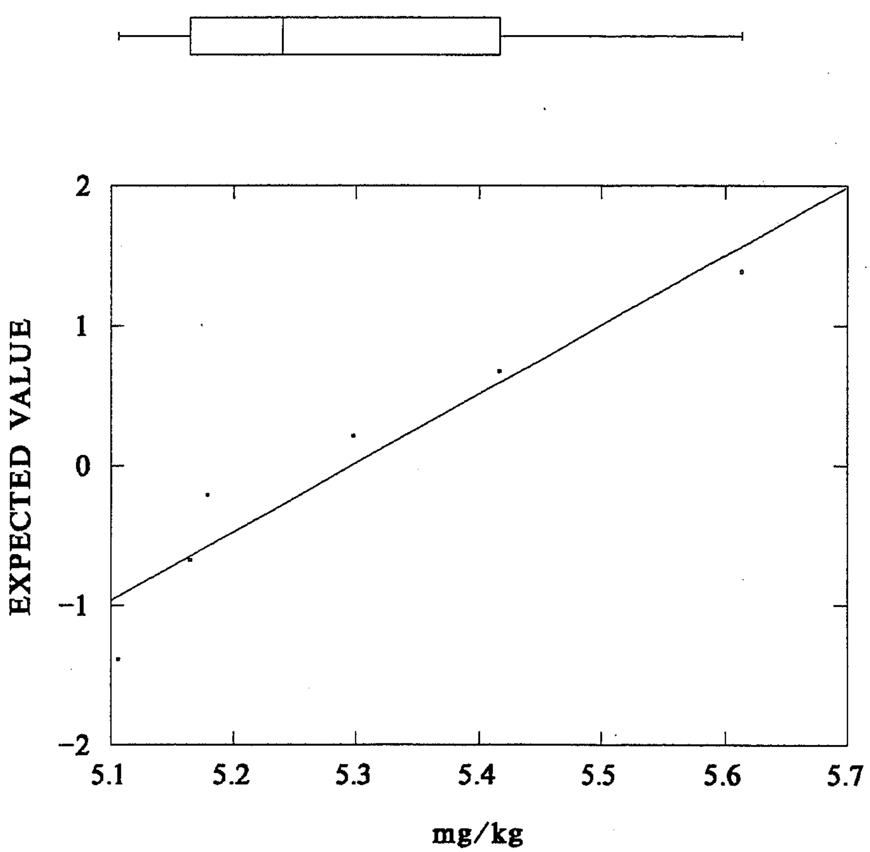
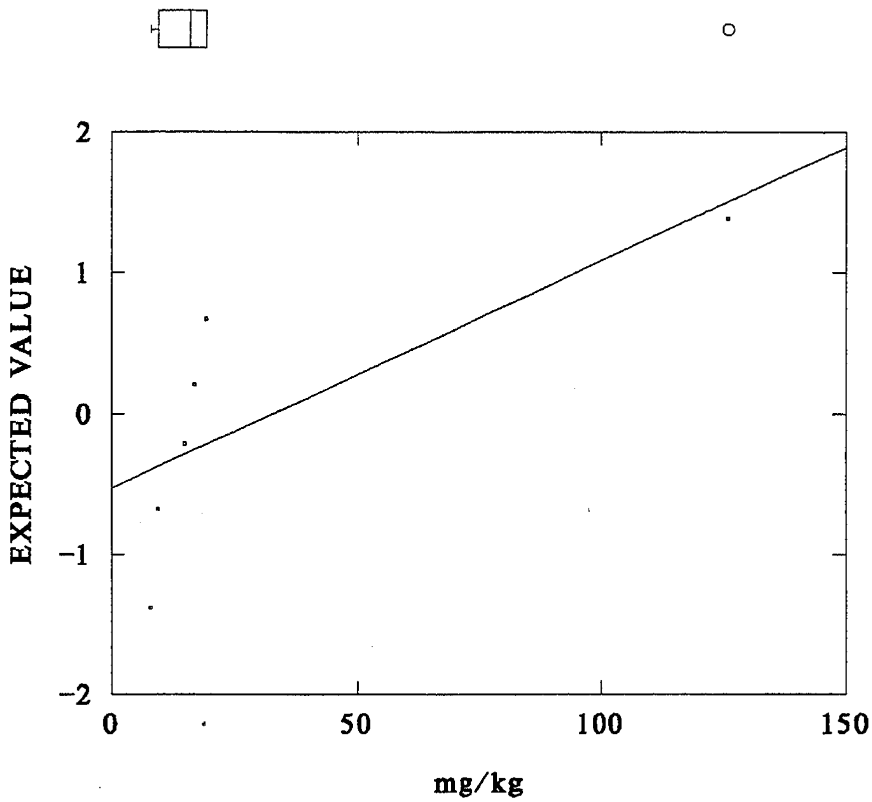


Figure M-21. Goodness-of-Fit Tests Using Probability and Box Plots: Lead in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



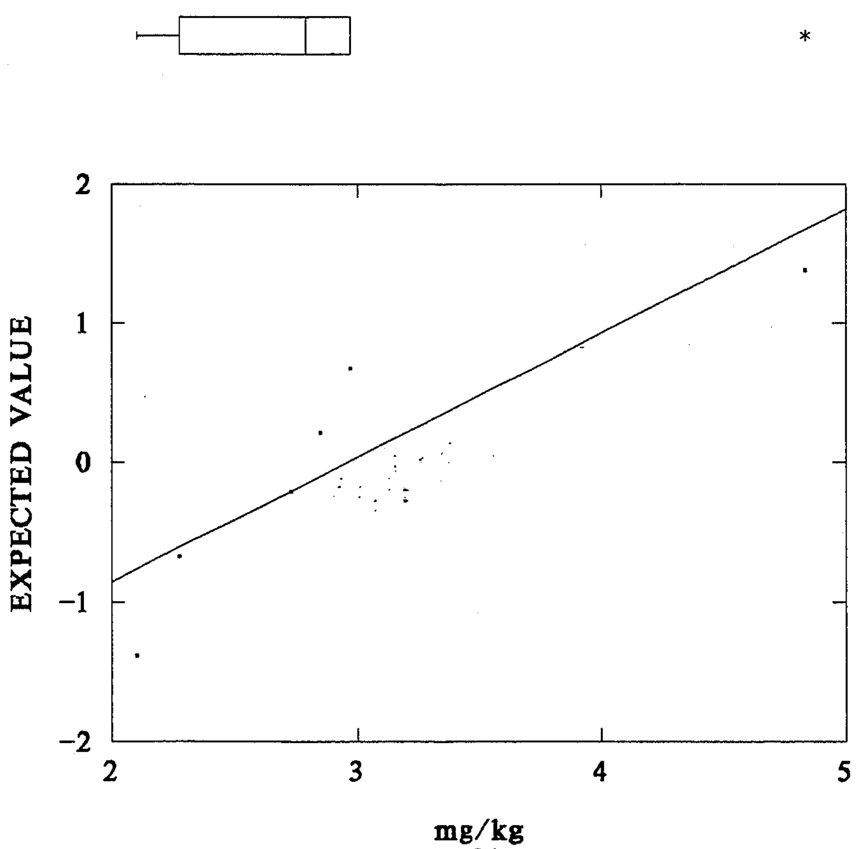
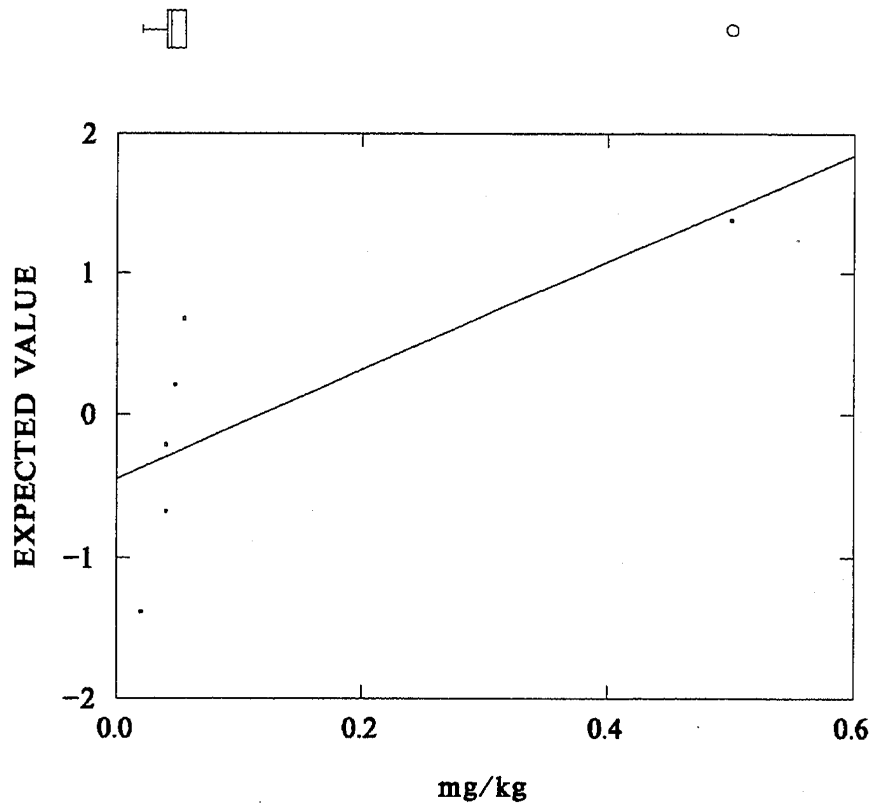


Figure M-22. Goodness-of-Fit Tests Using Probability and Box Plots: Mercury in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



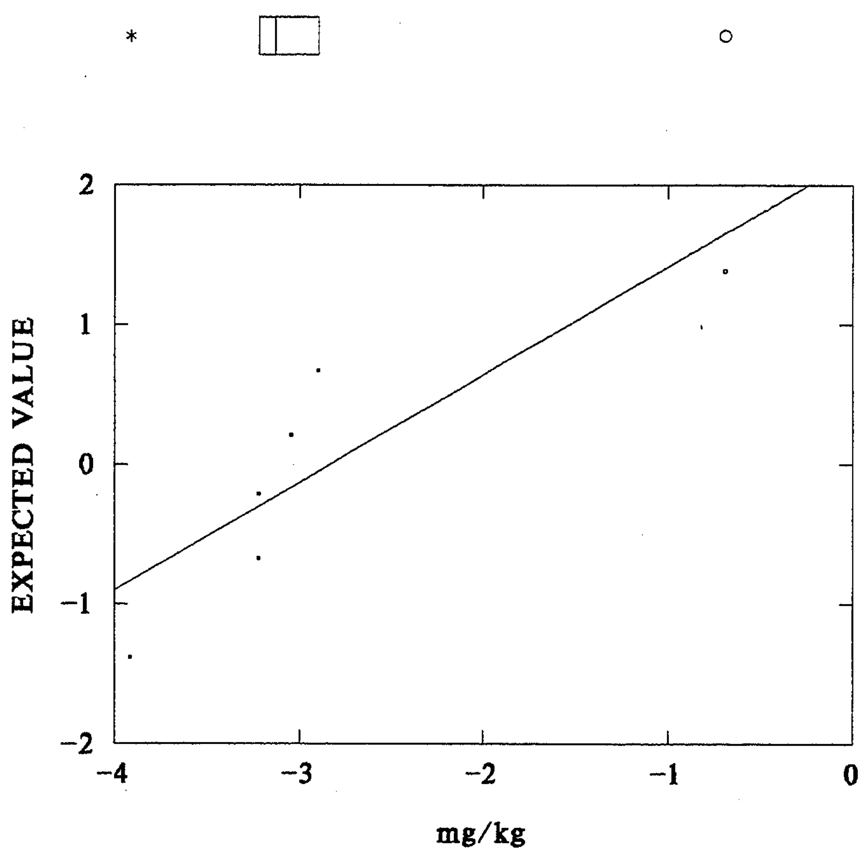
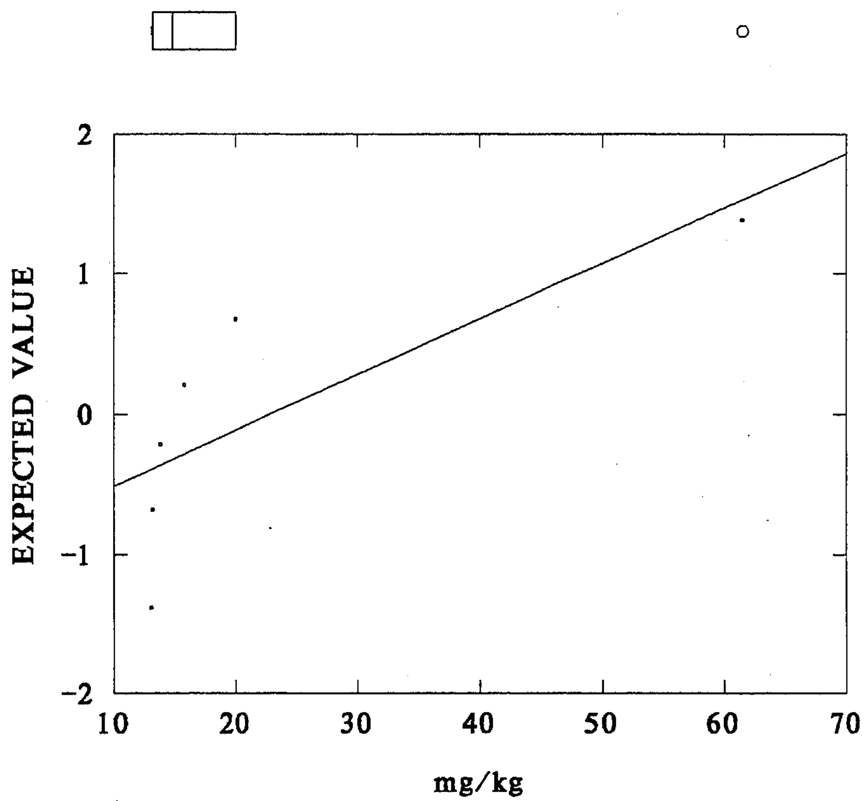


Figure M-23. Goodness-of-Fit Tests Using Probability and Box Plots: Nickel in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



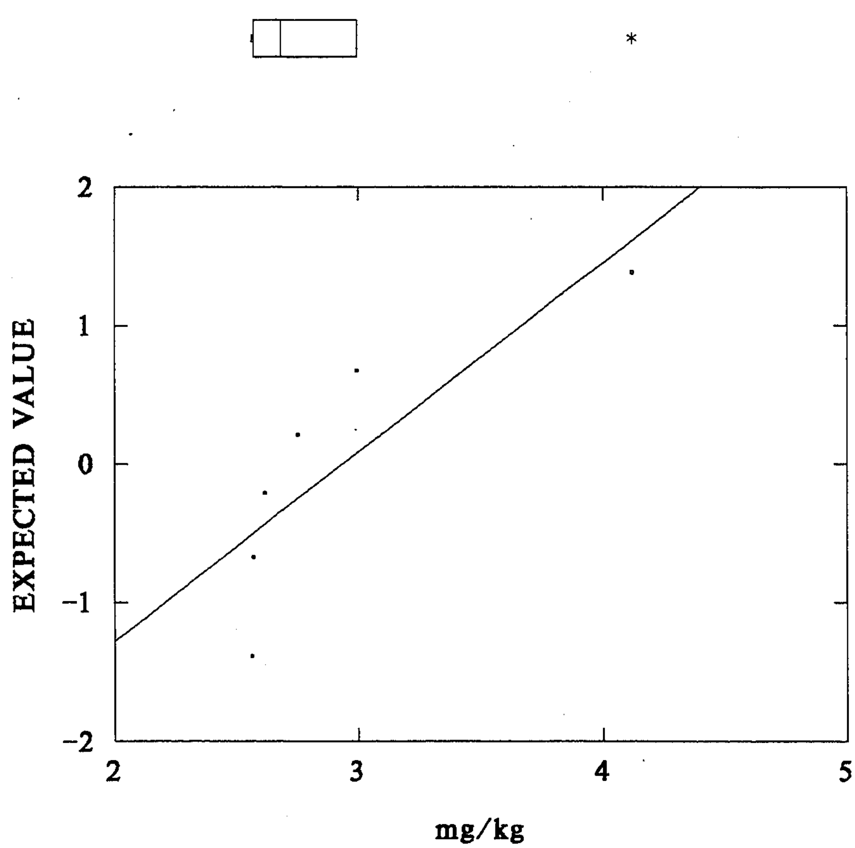
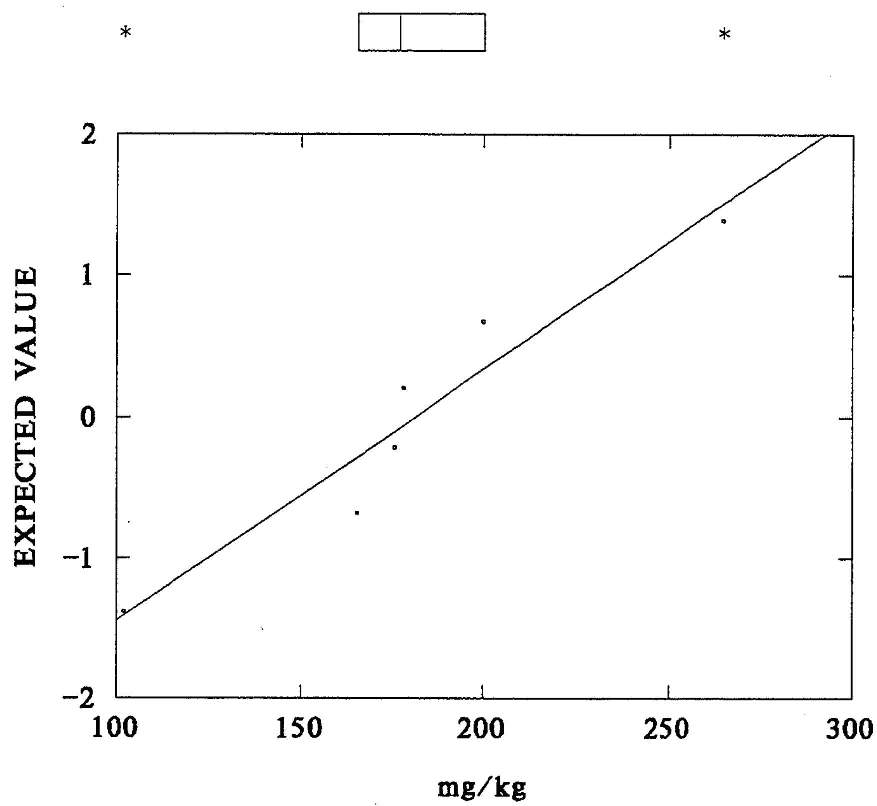


Figure M-24. Goodness-of-Fit Tests Using Probability and Box Plots: Phenanthrene in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



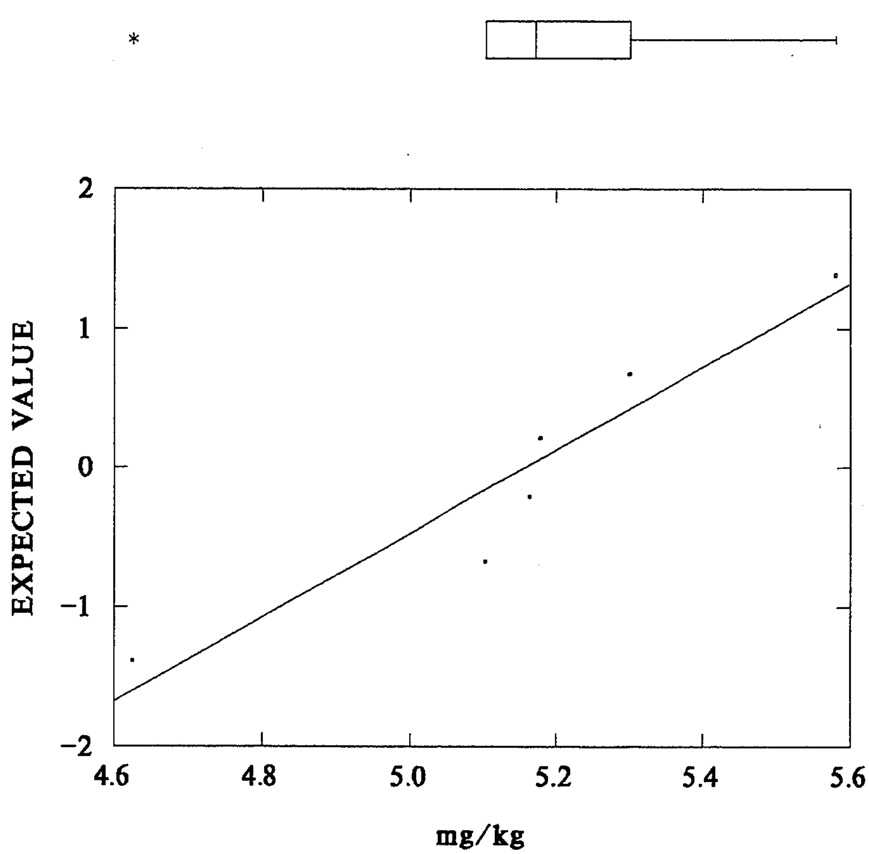
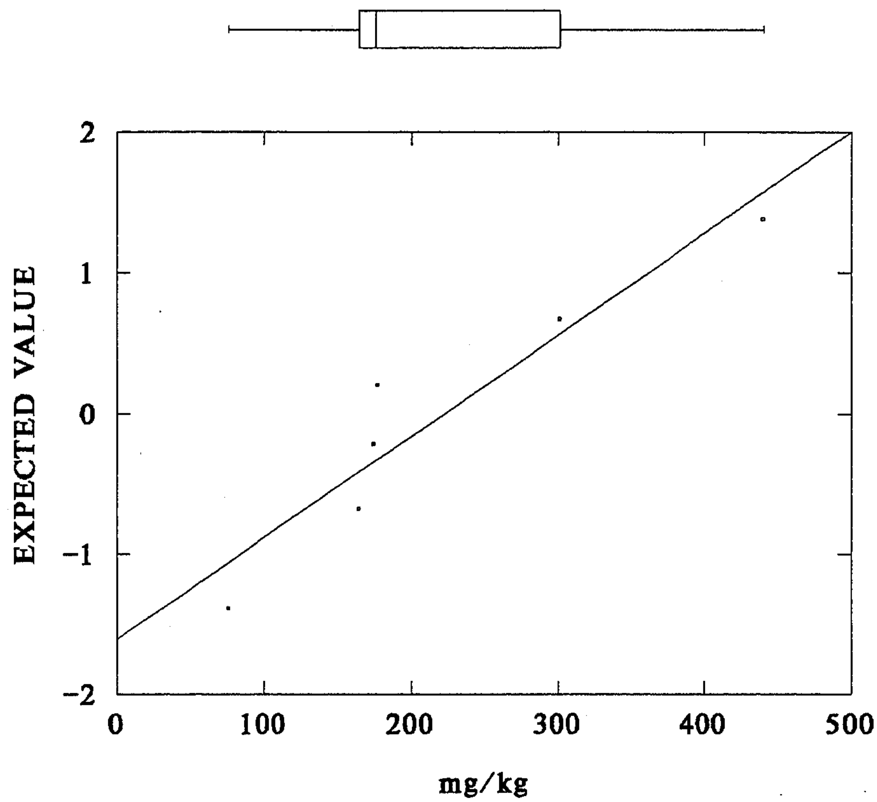


Figure M-25. Goodness-of-Fit Tests Using Probability and Box Plots: Pyrene in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



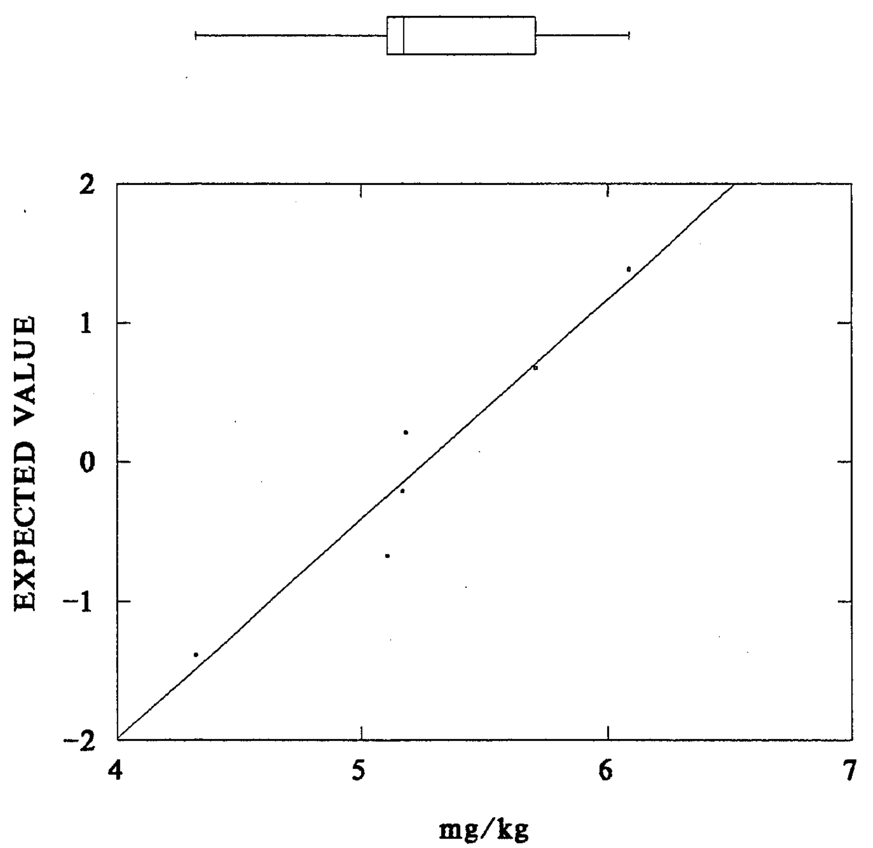
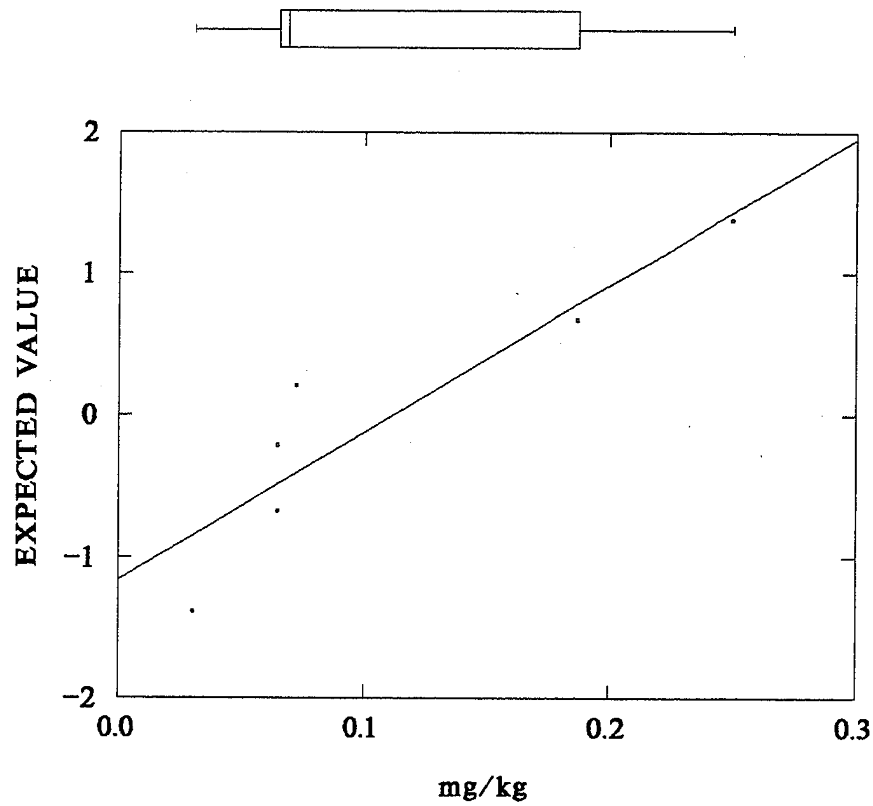


Figure M-26. Goodness-of-Fit Tests Using Probability and Box Plots: Selenium in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



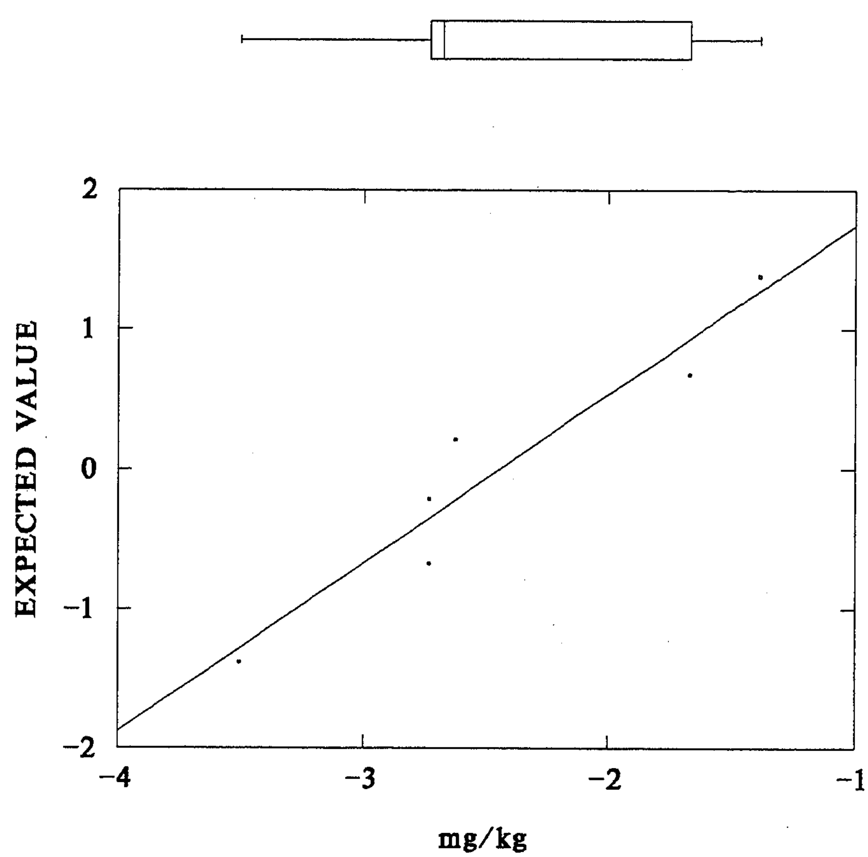
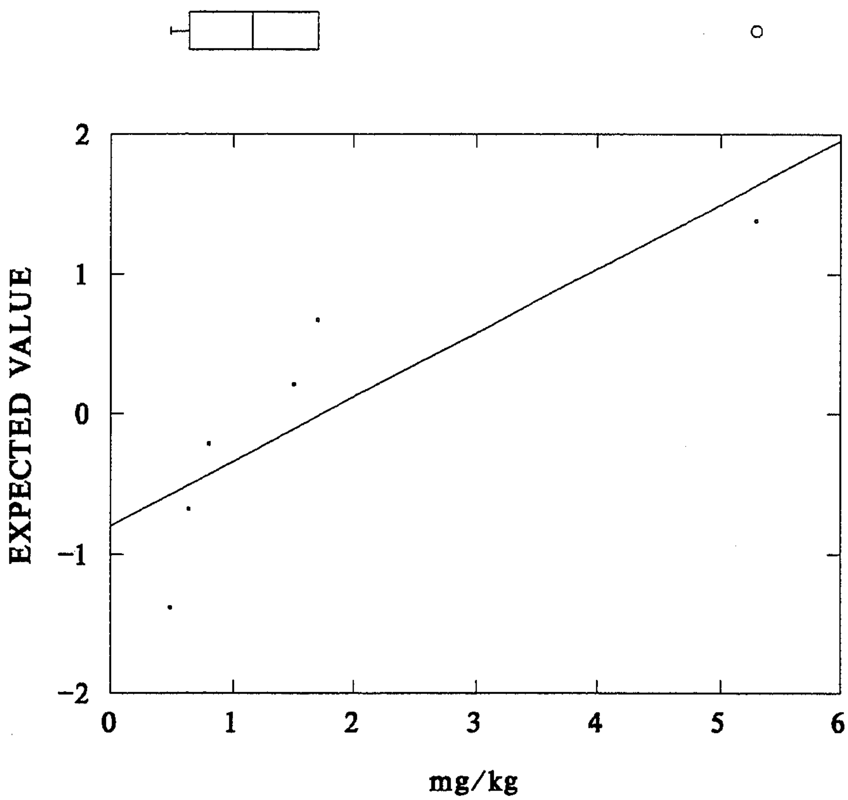


Figure M-27. Goodness-of-Fit Tests Using Probability and Box Plots: Silver in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



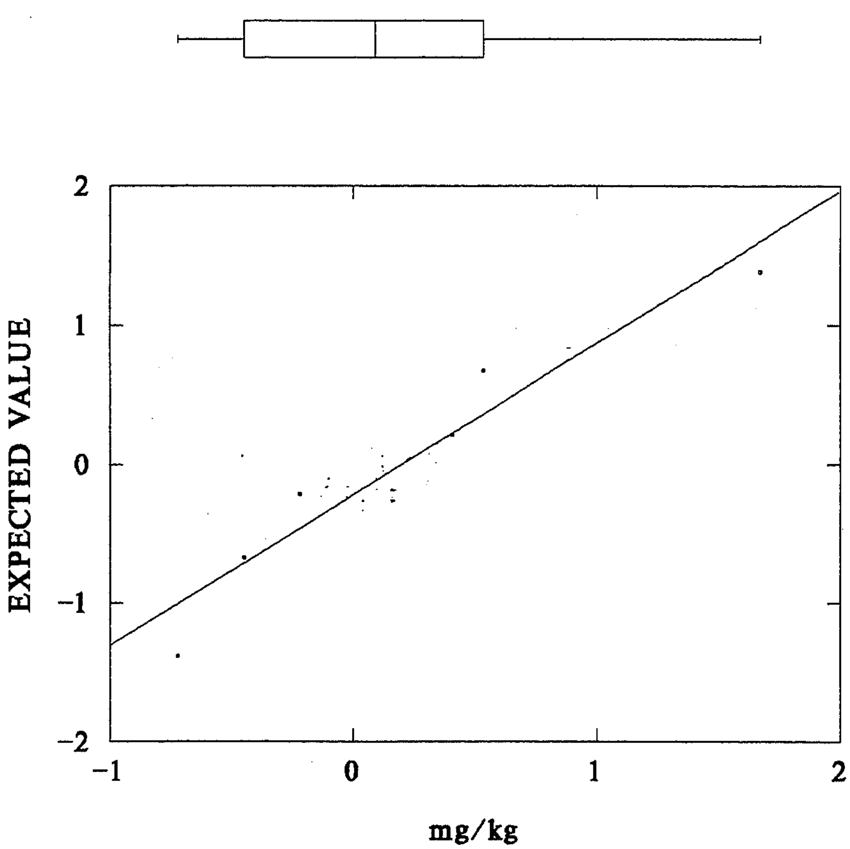
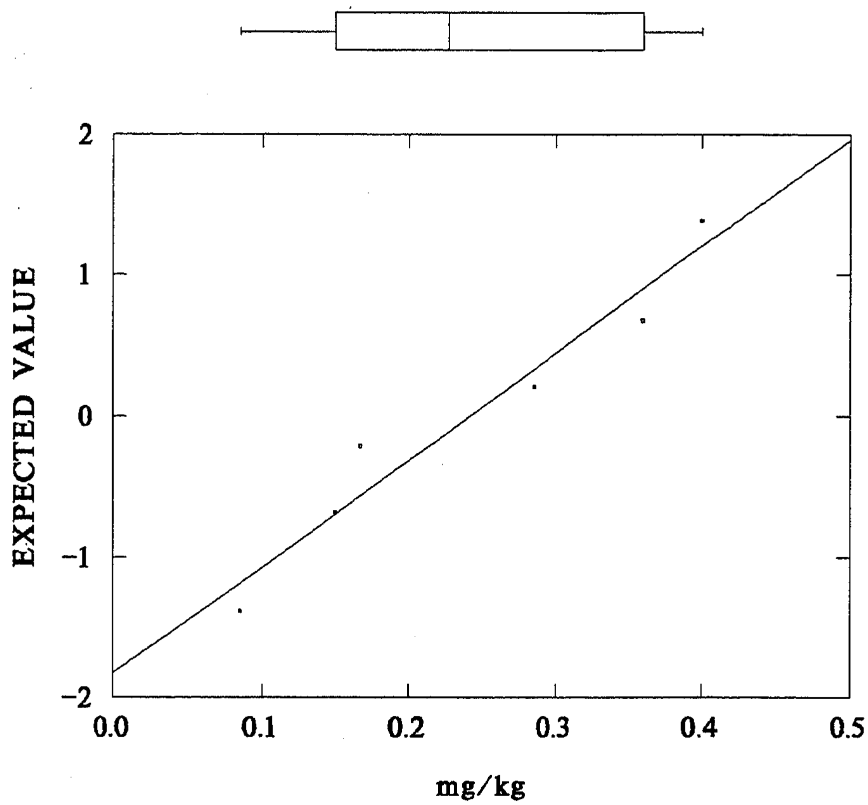


Figure M-28. Goodness-of-Fit Tests Using Probability and Box Plots: Thallium in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



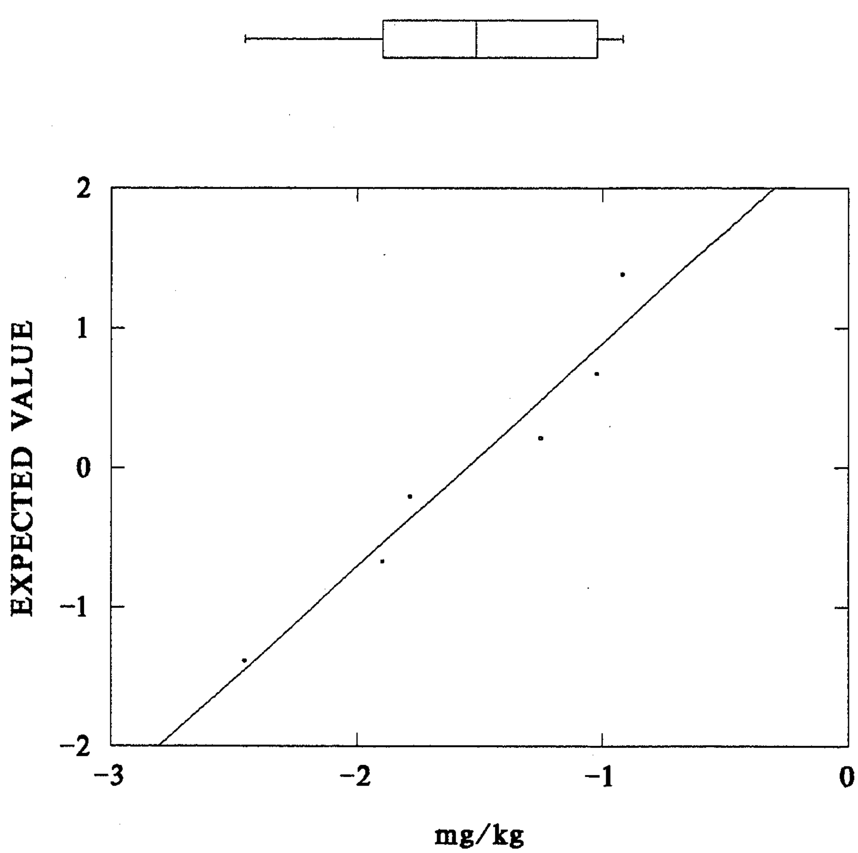
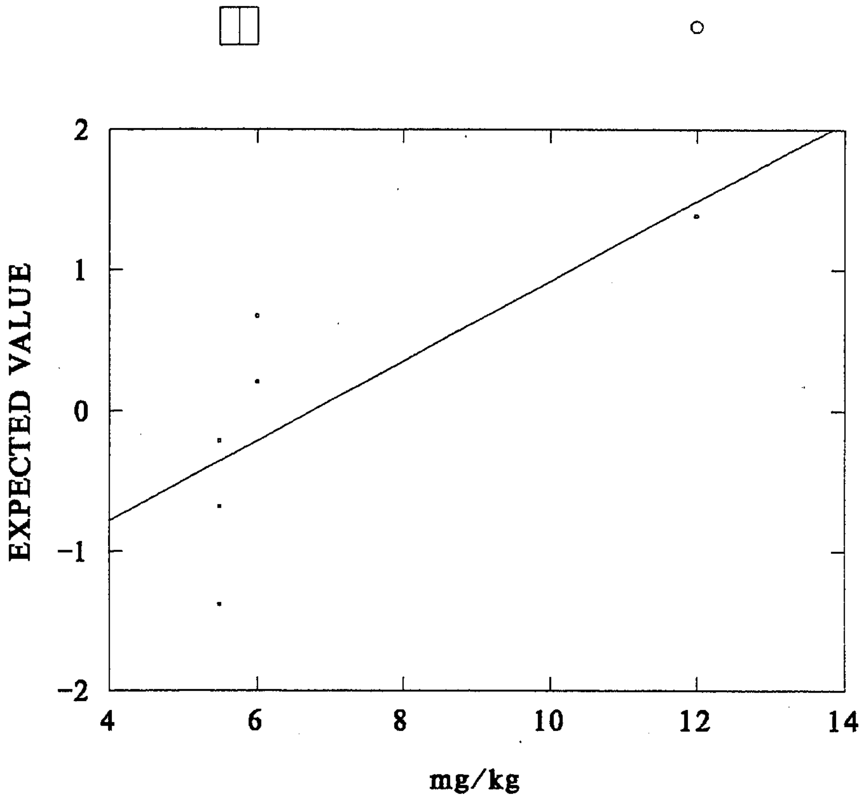


Figure M-29. Goodness-of-Fit Tests Using Probability and Box Plots: Toluene in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



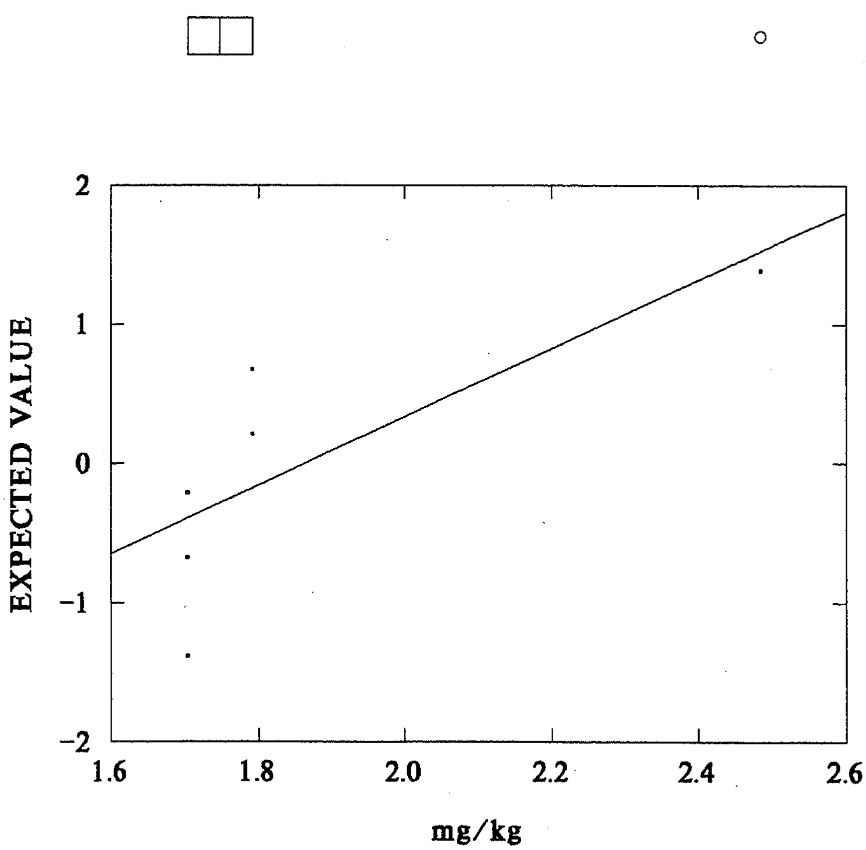
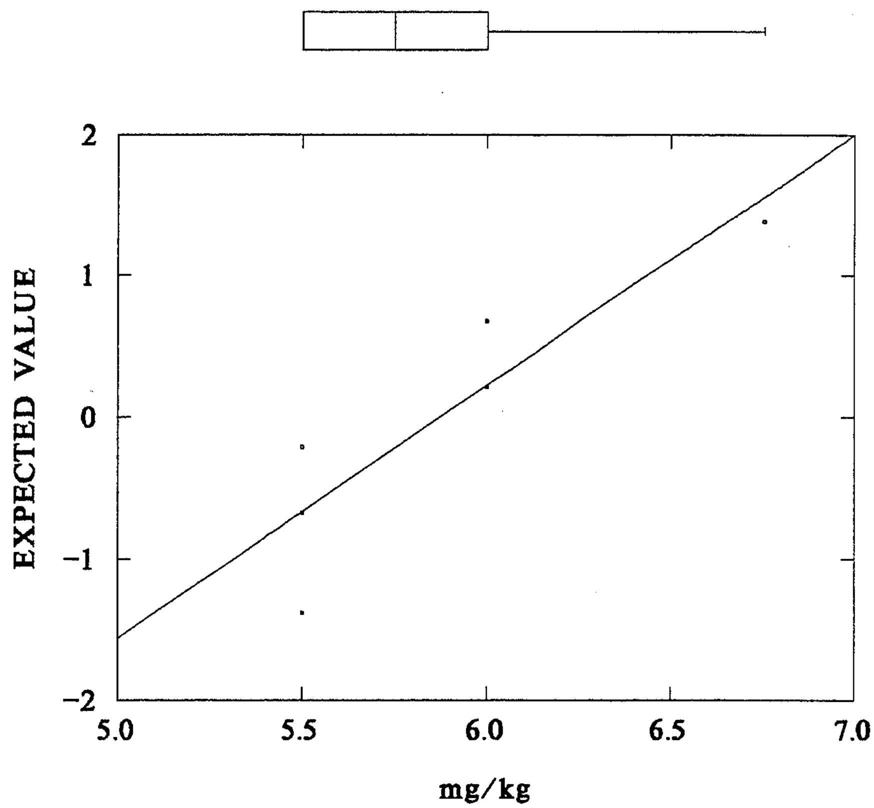


Figure M-30. Goodness-of-Fit Tests Using Probability and Box Plots: Xylenes in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



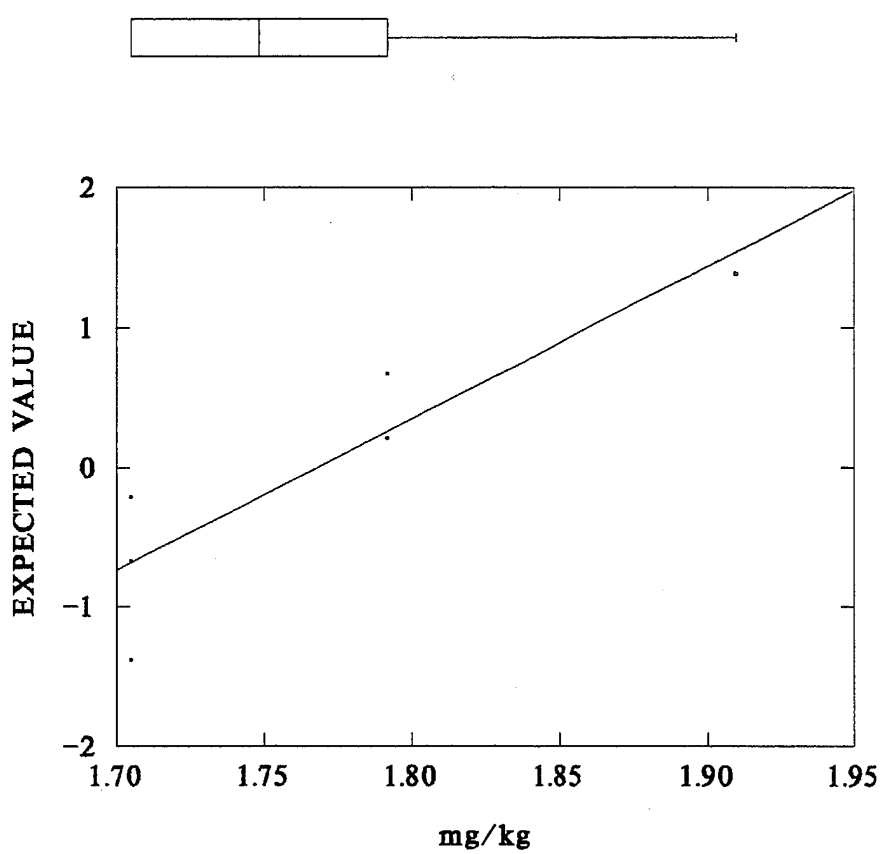
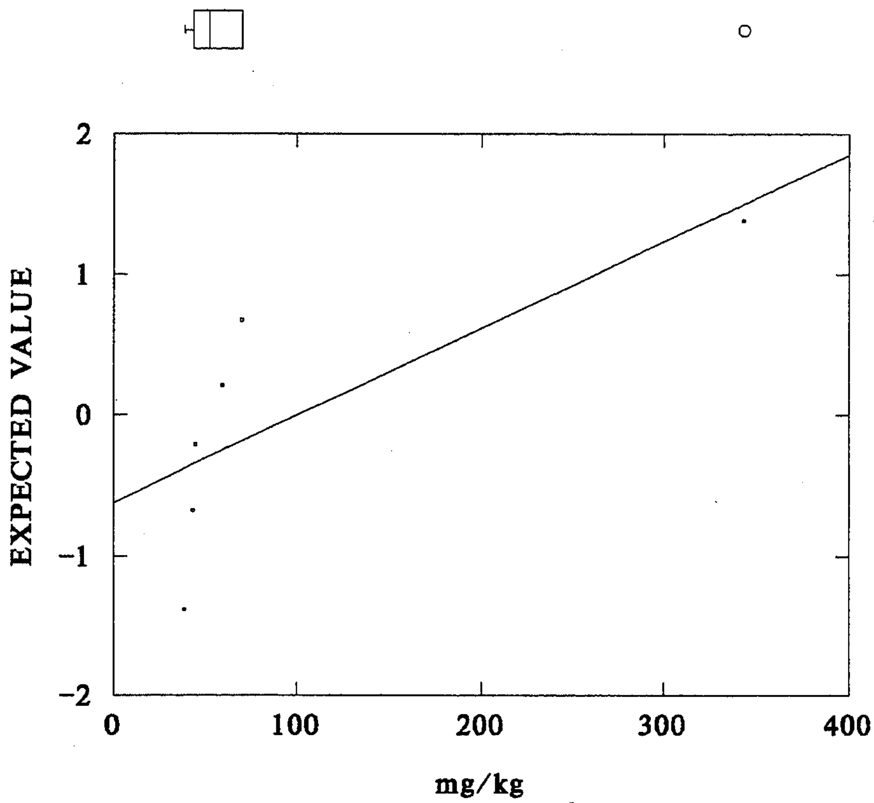


Figure M-31. Goodness-of-Fit Tests Using Probability and Box Plots: Zinc in Soil (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



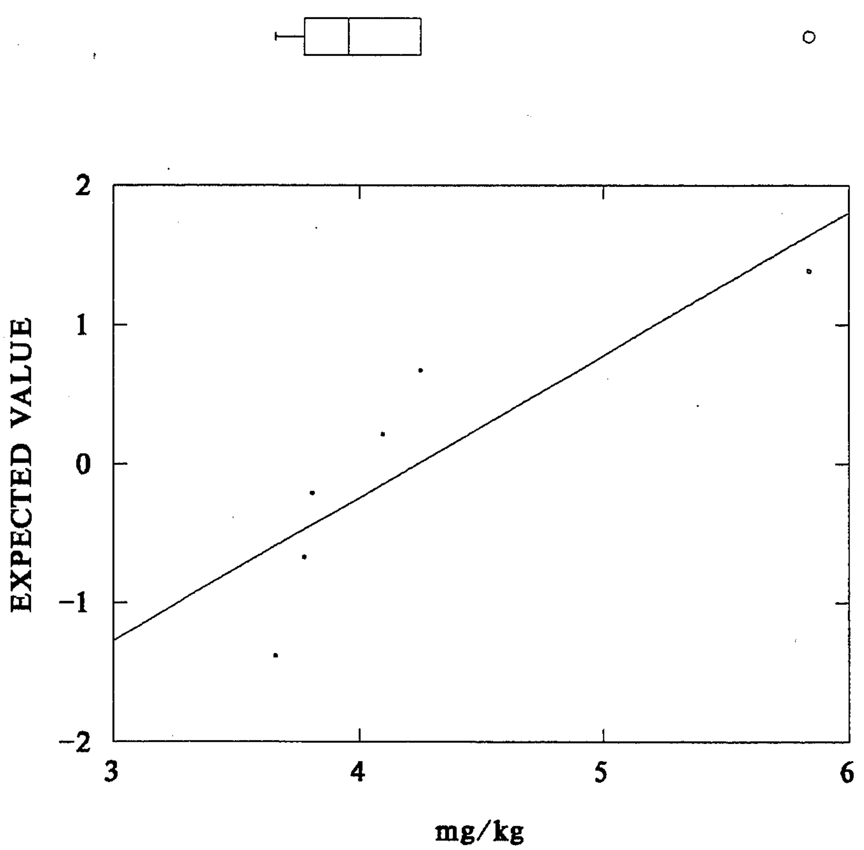
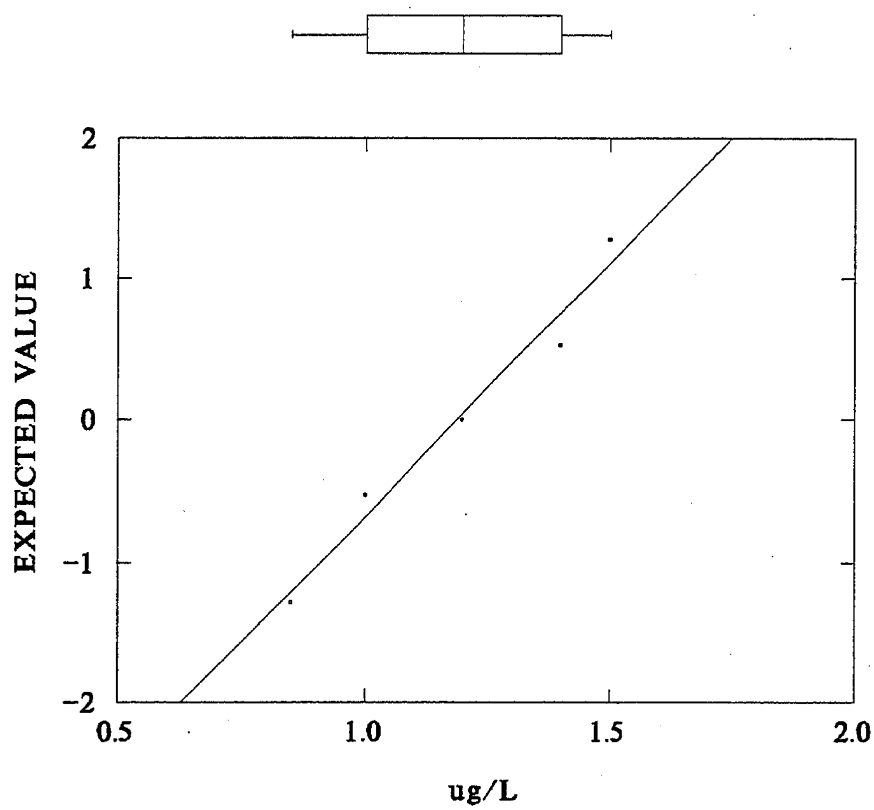


Figure M-32. Goodness-of-Fit Tests Using Probability and Box Plots: Antimony in Water (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



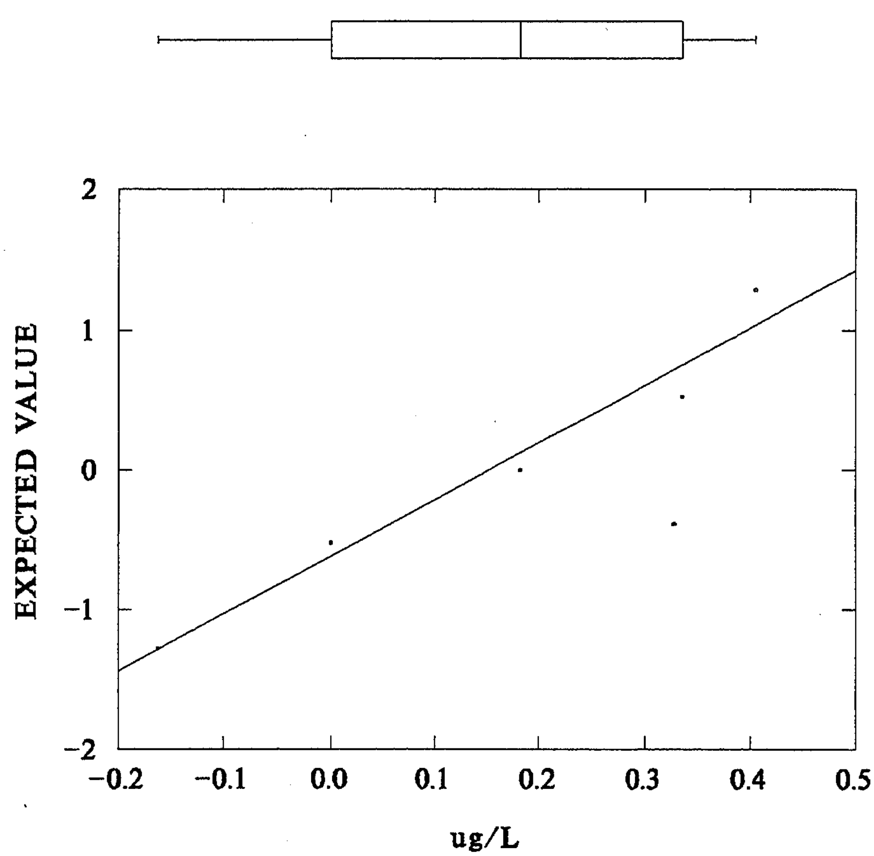
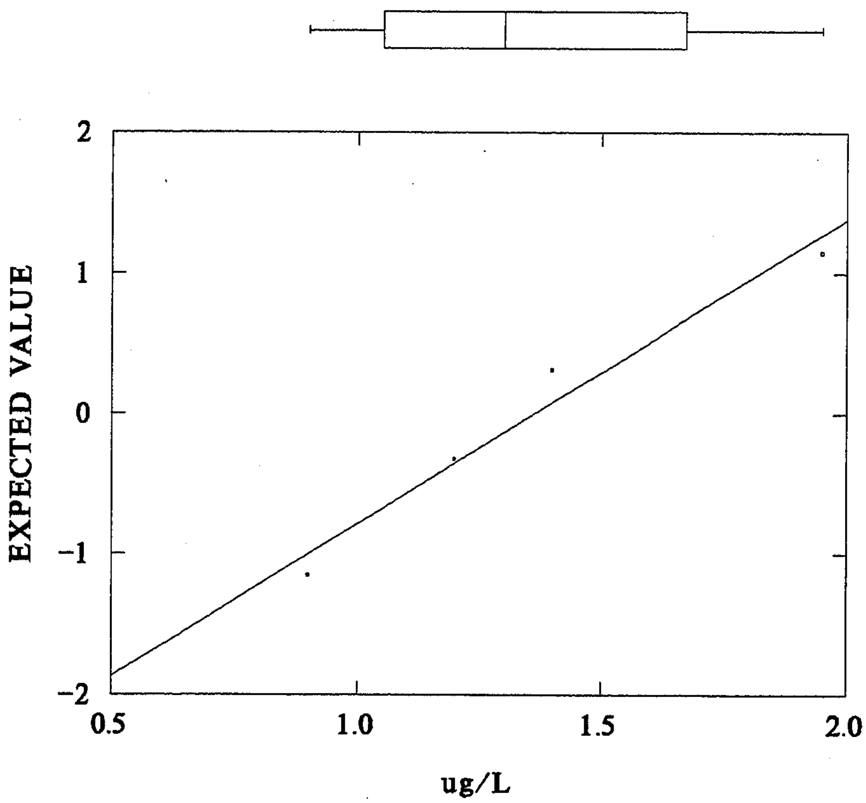


Figure M-33. Goodness-of-Fit Tests Using Probability and Box Plots: Dissolved antimony in Water (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



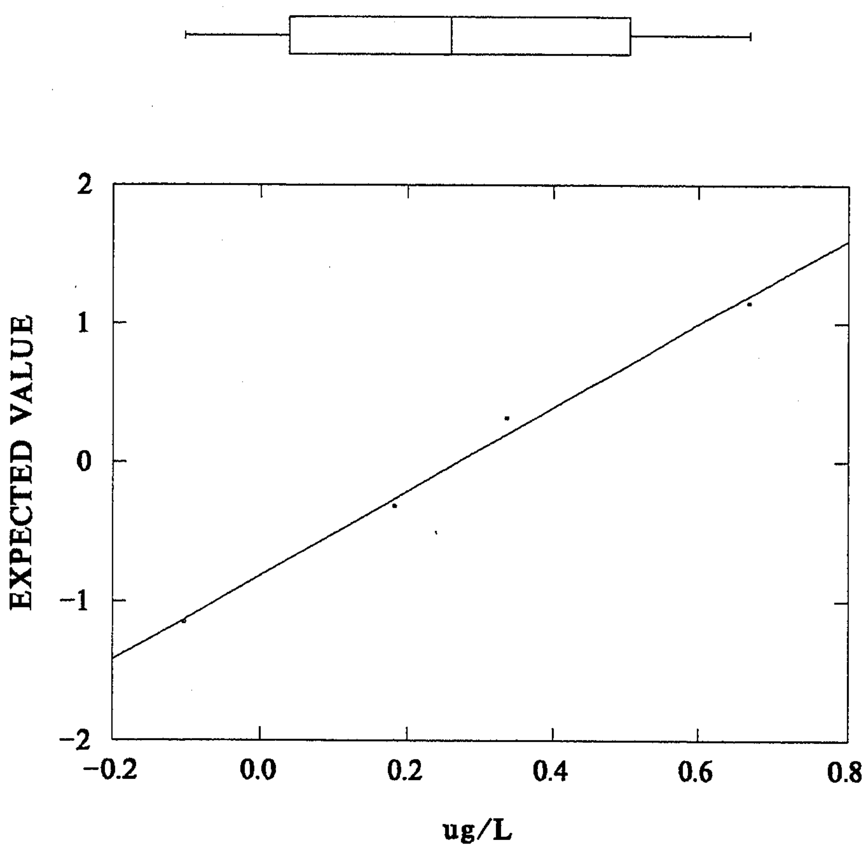
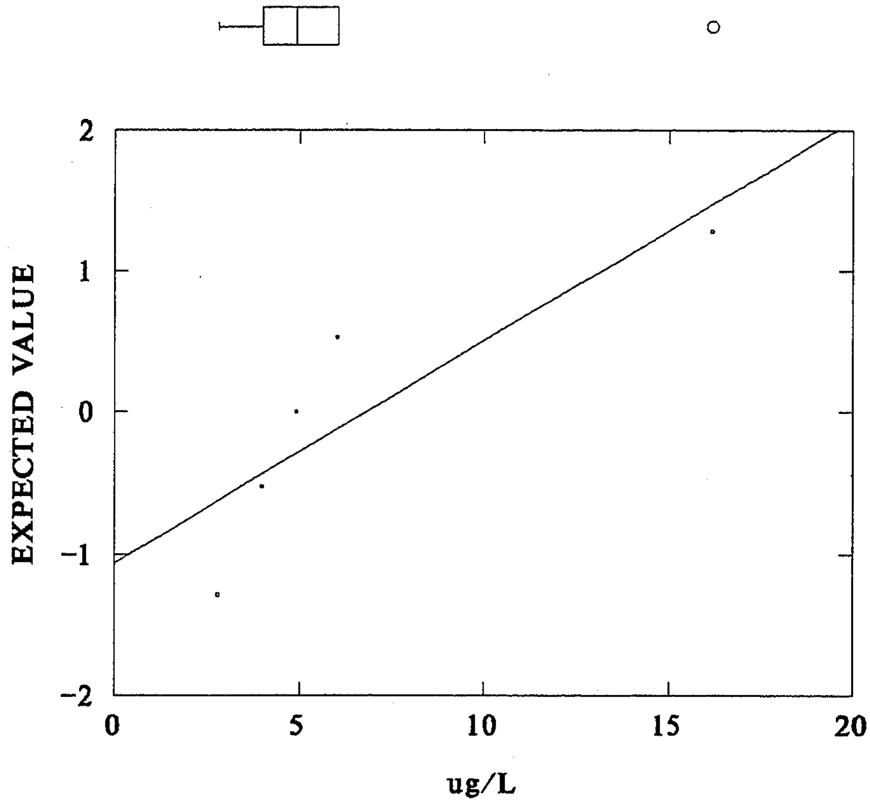


Figure M-34. Goodness-of-Fit Tests Using Probability and Box Plots: Arsenic in Water (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



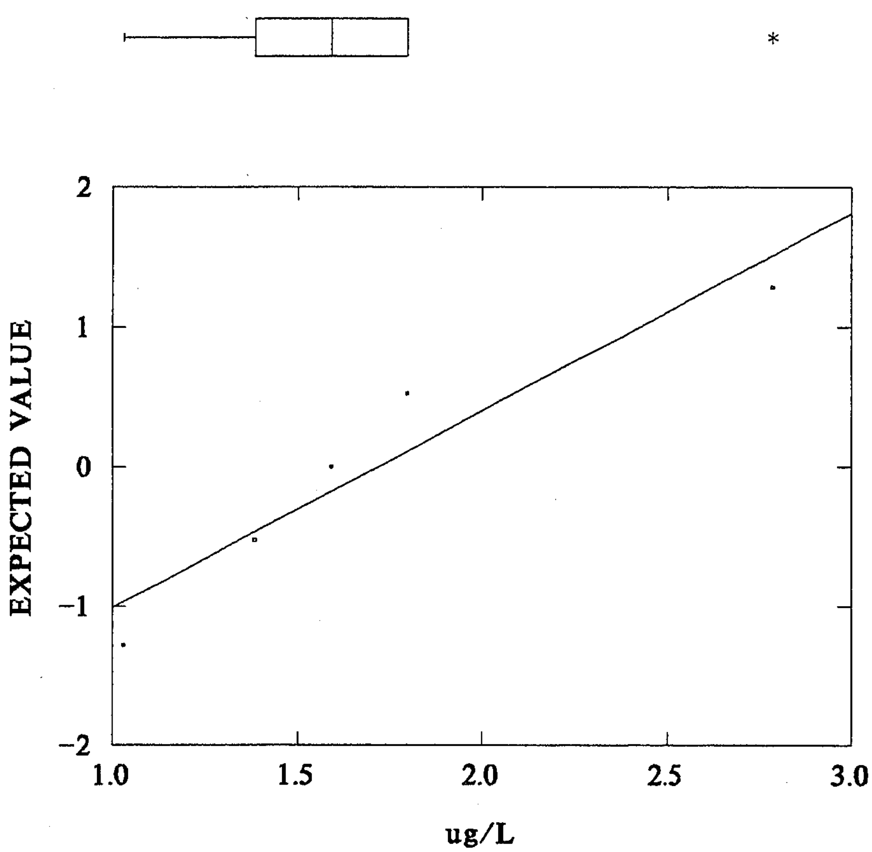


Figure M-35. Goodness-of-Fit Tests Using Probability and Box Plots: Beryllium in Water (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

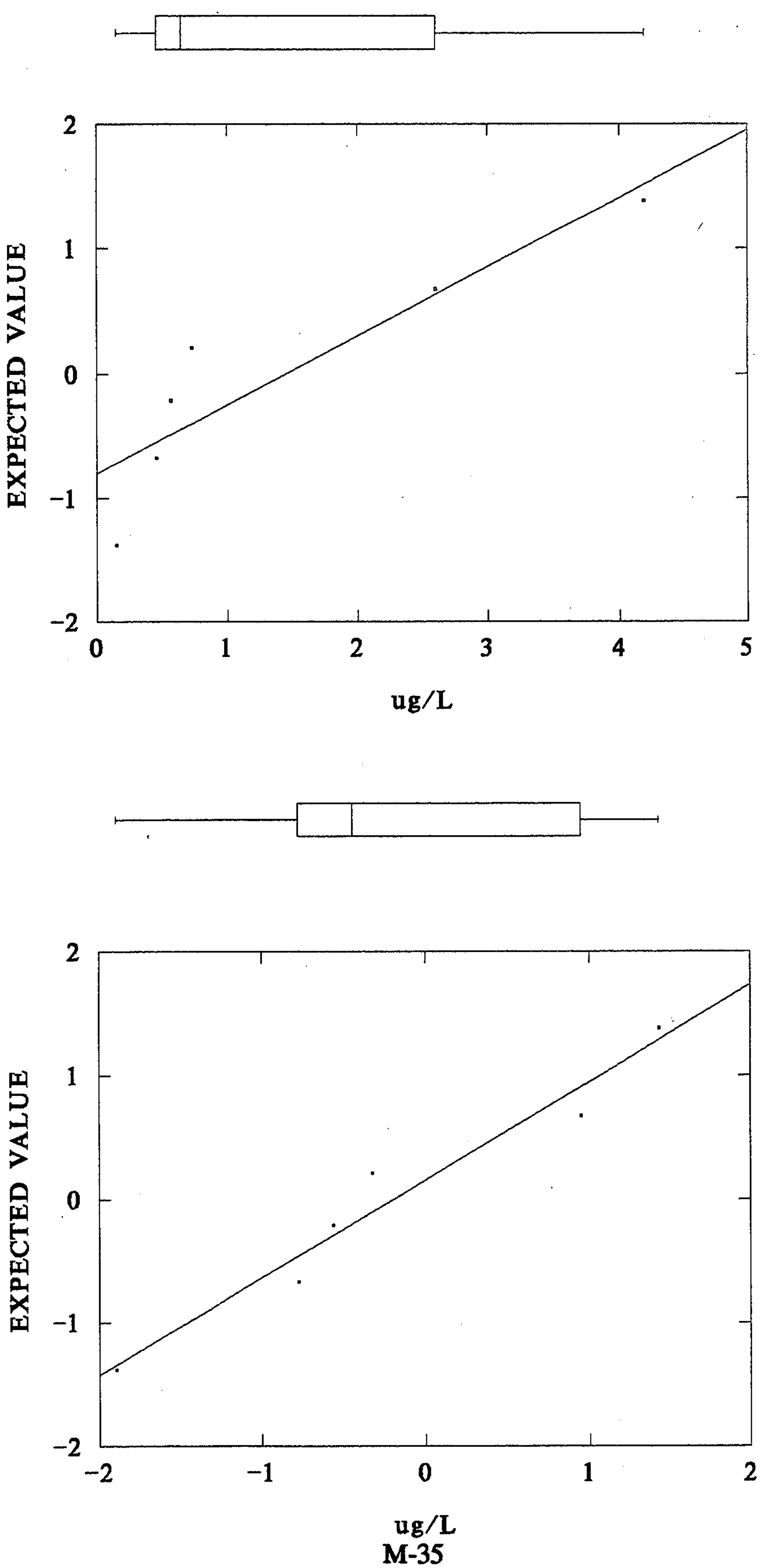
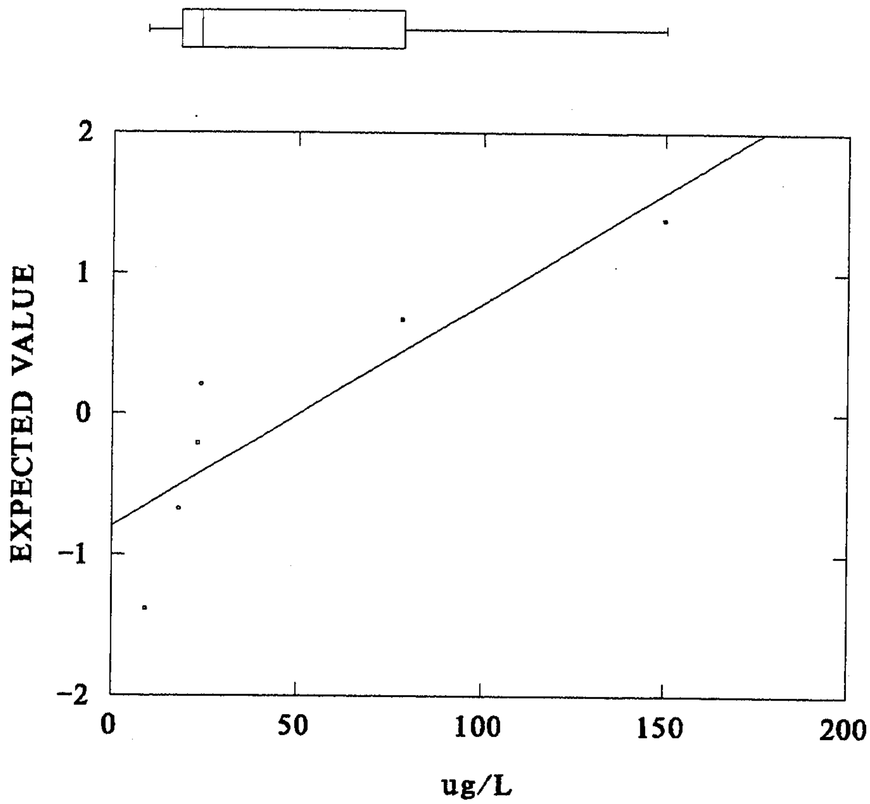


Figure M-36. Goodness-of-Fit Tests Using Probability and Box Plots: Chromium in Water (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



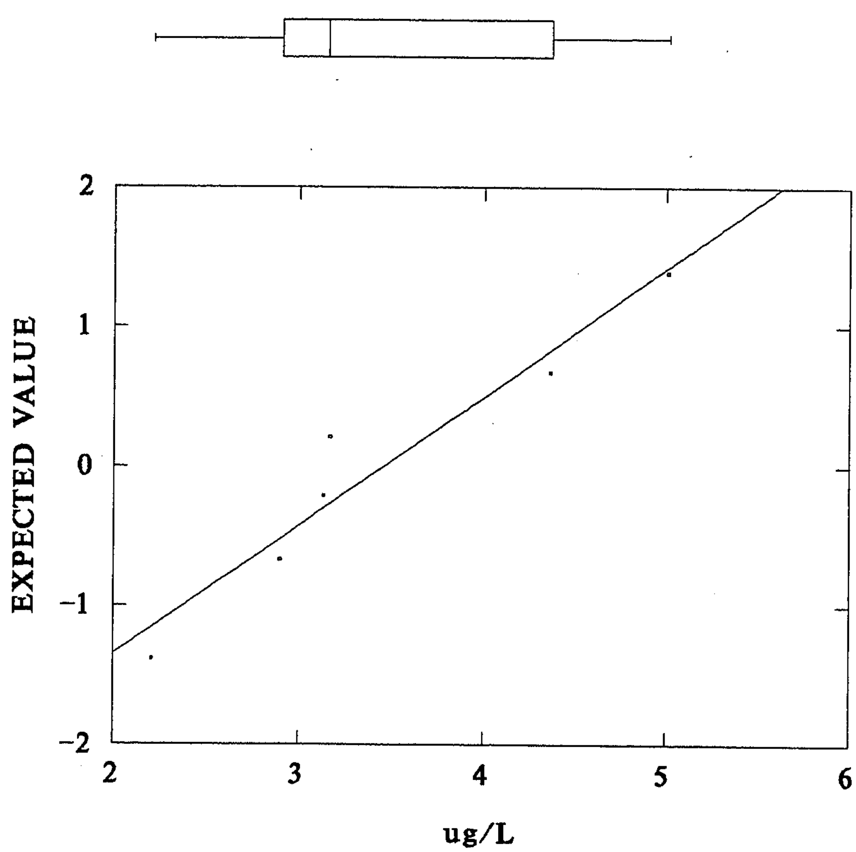
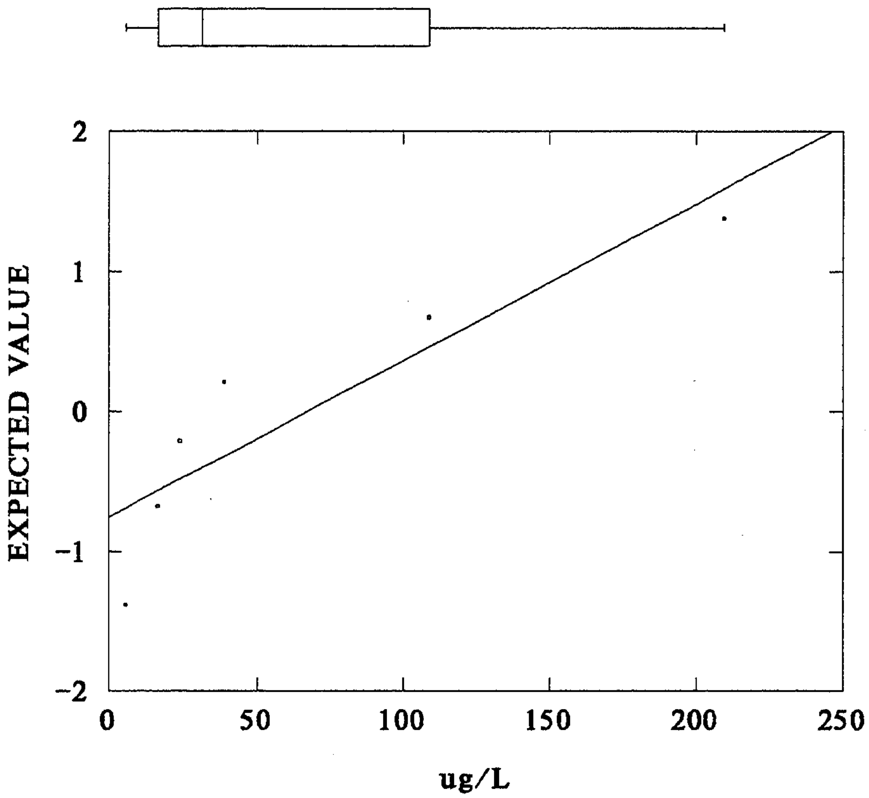


Figure M-37. Goodness-of-Fit Tests Using Probability and Box Plots: Copper in Water (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



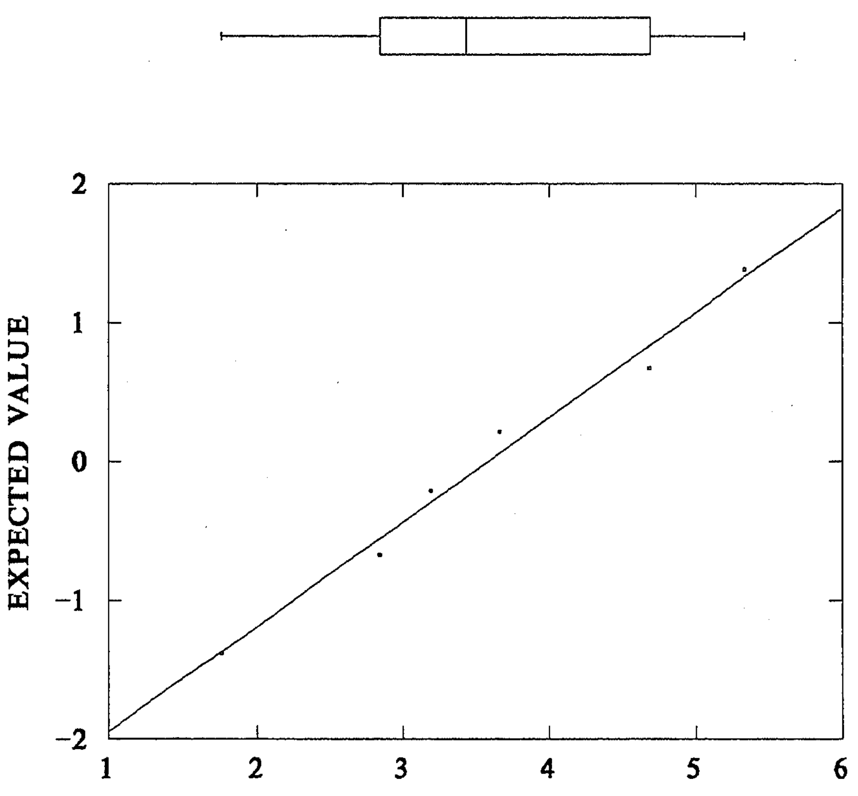
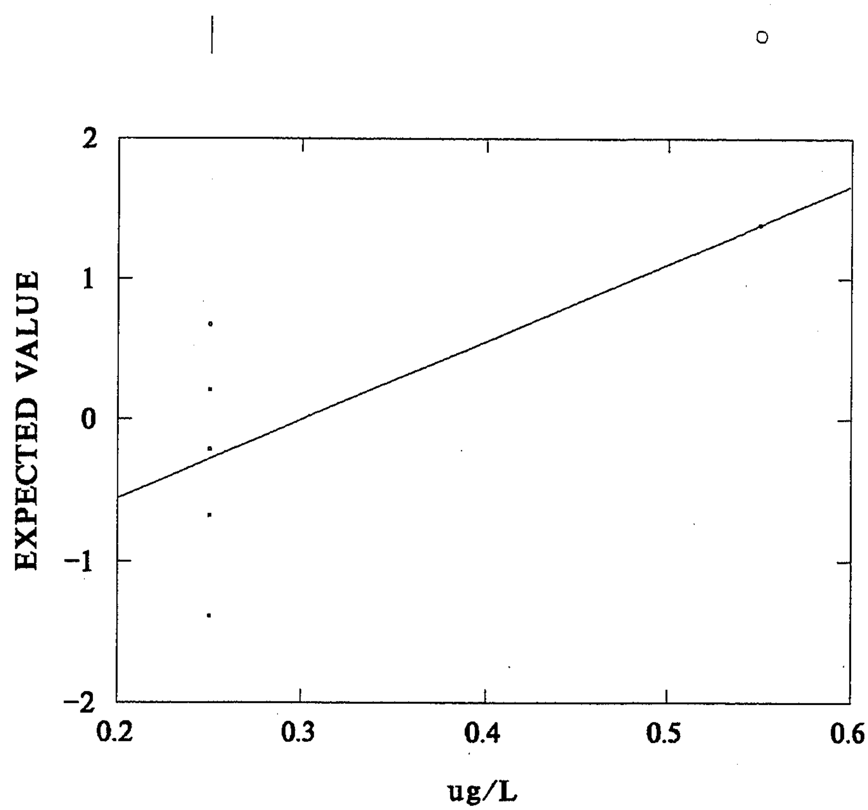


Figure M-38. Goodness-of-Fit Tests Using Probability and Box Plots: 1,2-Dichloroethylene in Water (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



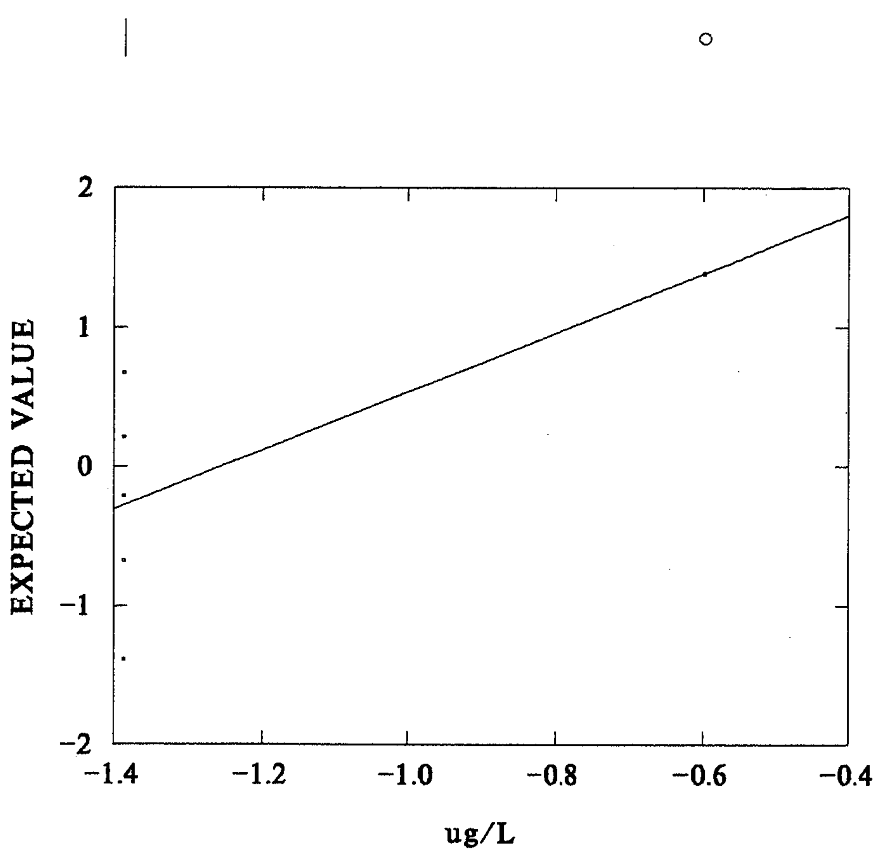
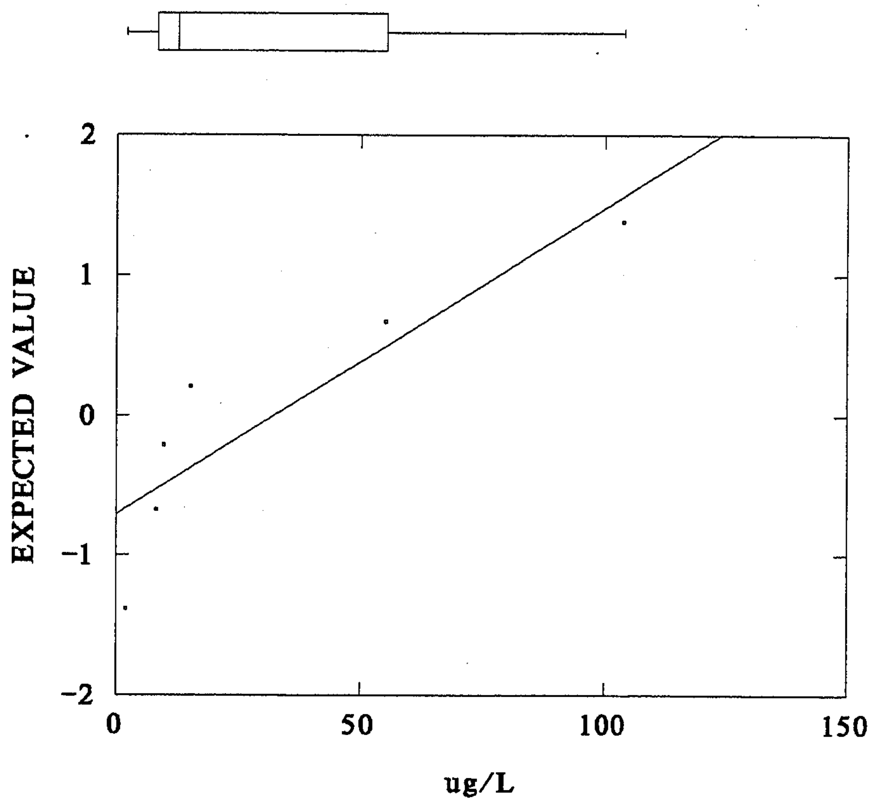


Figure M-39. Goodness-of-Fit Tests Using Probability and Box Plots: Lead in Water (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



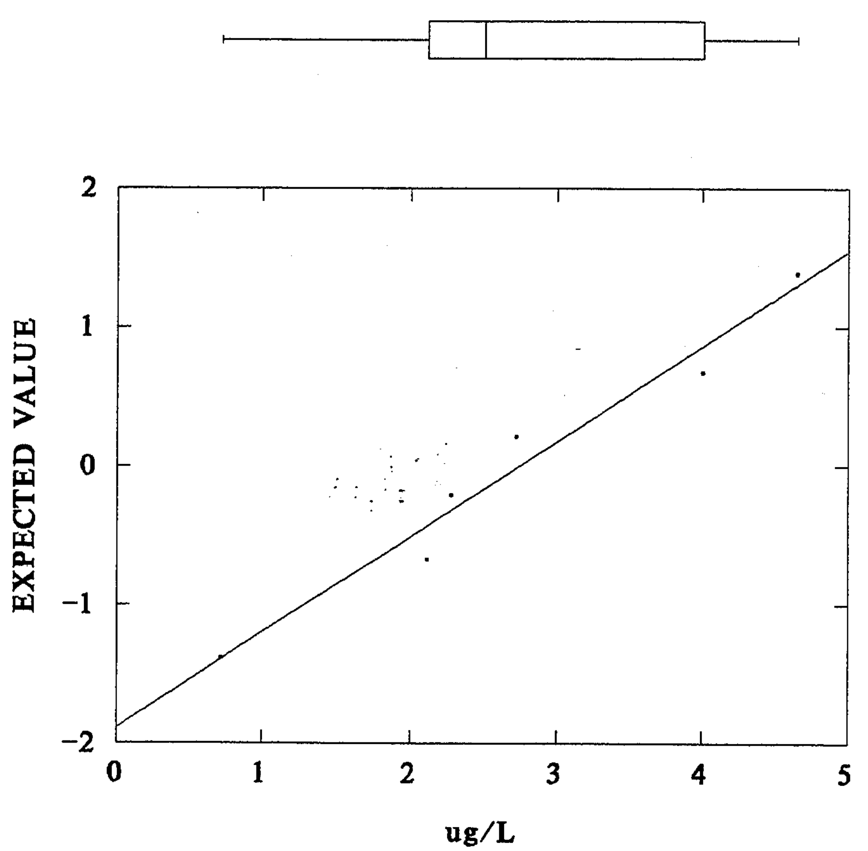
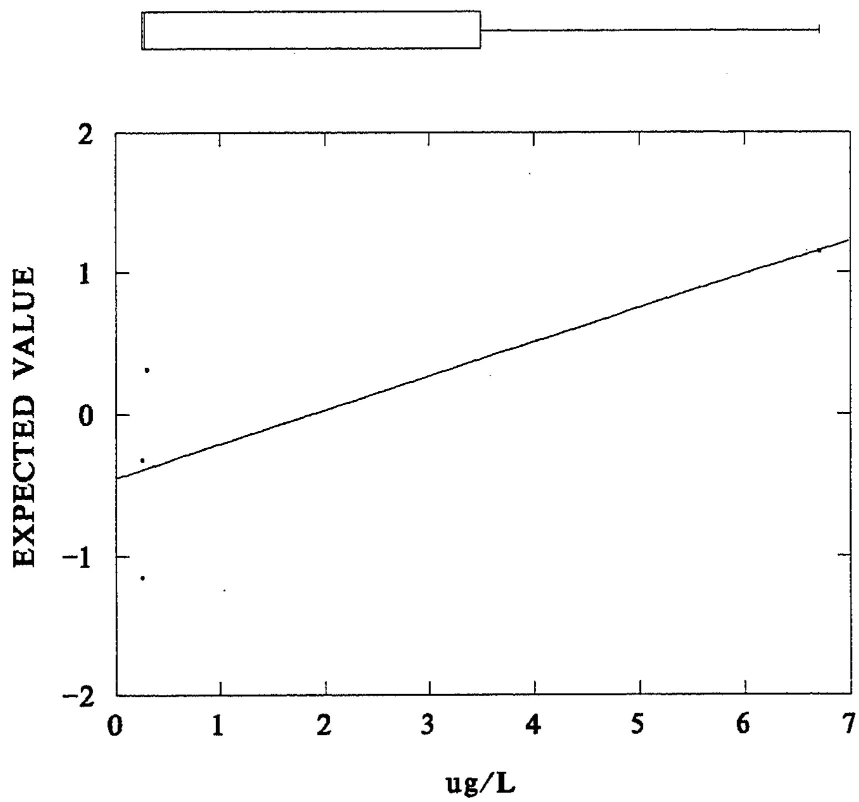


Figure M-40. Goodness-of-Fit Tests Using Probability and Box Plots: Dissolved lead in Water (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



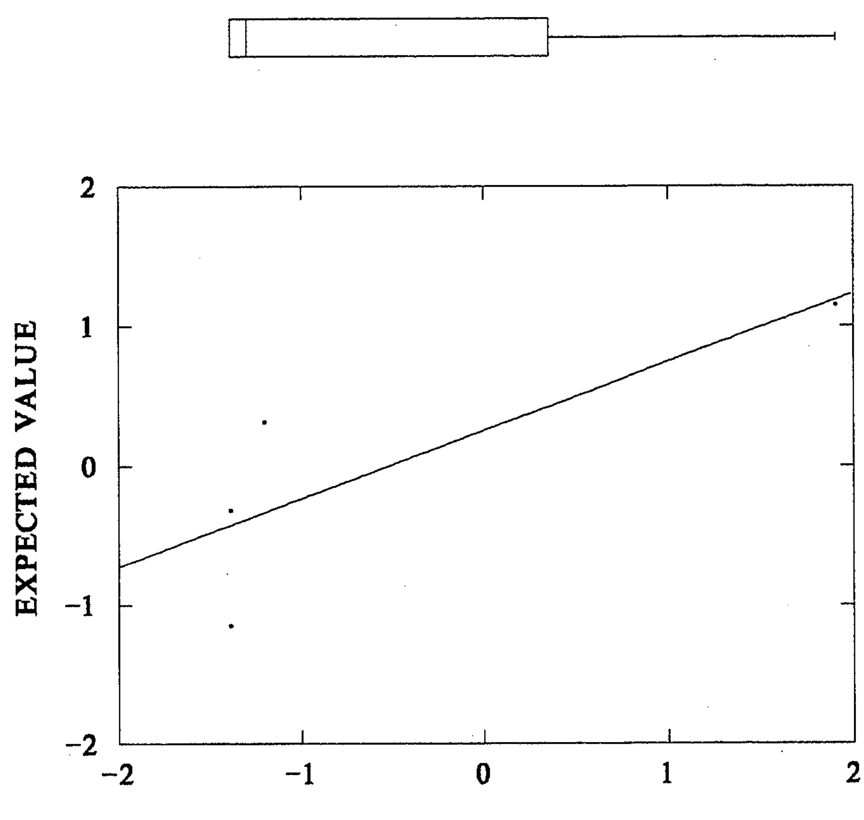
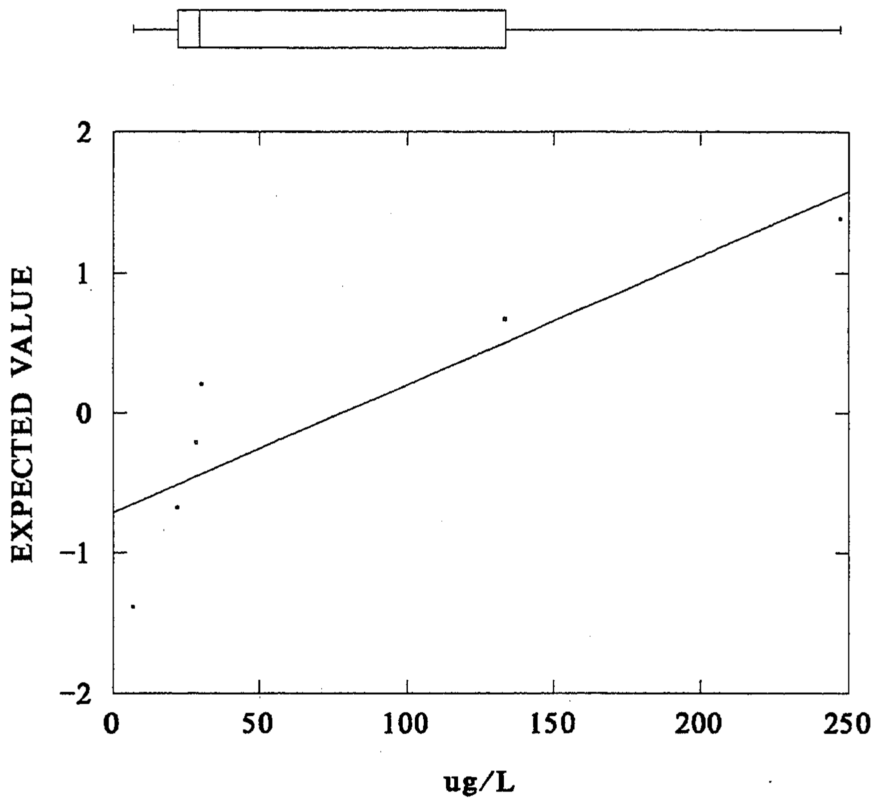


Figure M-41. Goodness-of-Fit Tests Using Probability and Box Plots: Nickel in Water (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



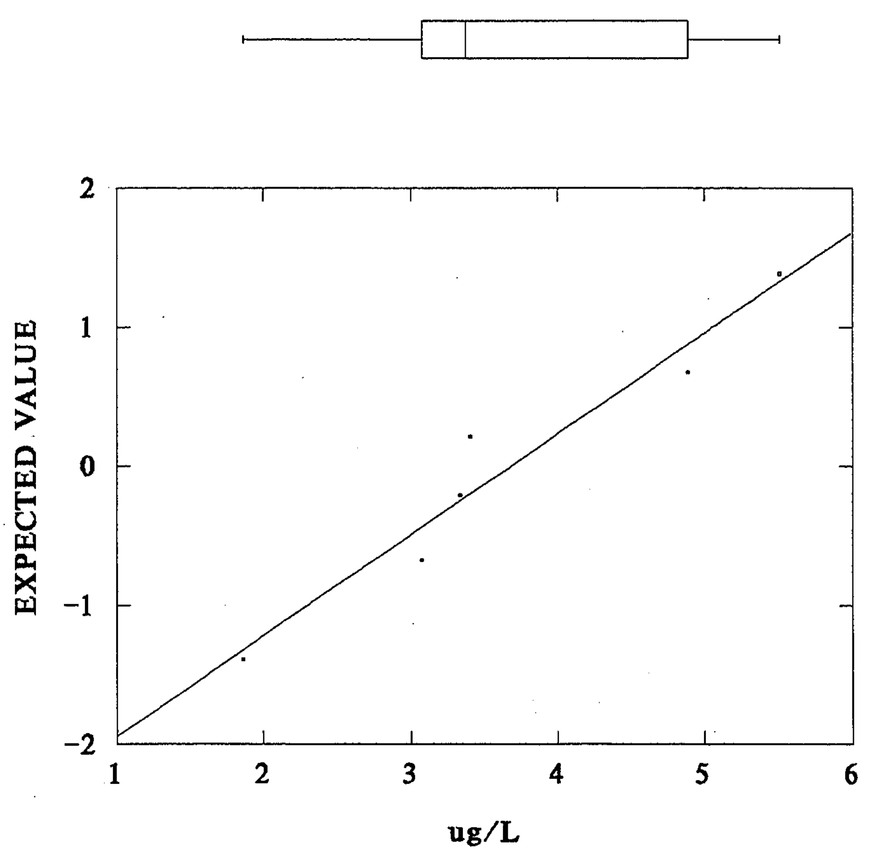
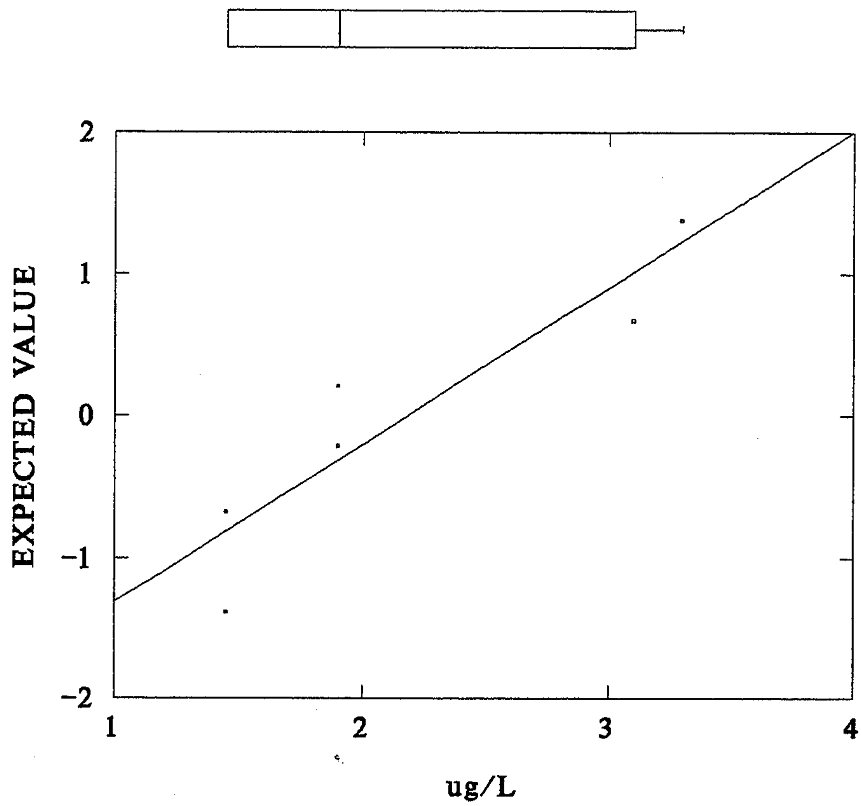


Figure M-42. Goodness-of-Fit Tests Using Probability and Box Plots: Silver in Water (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



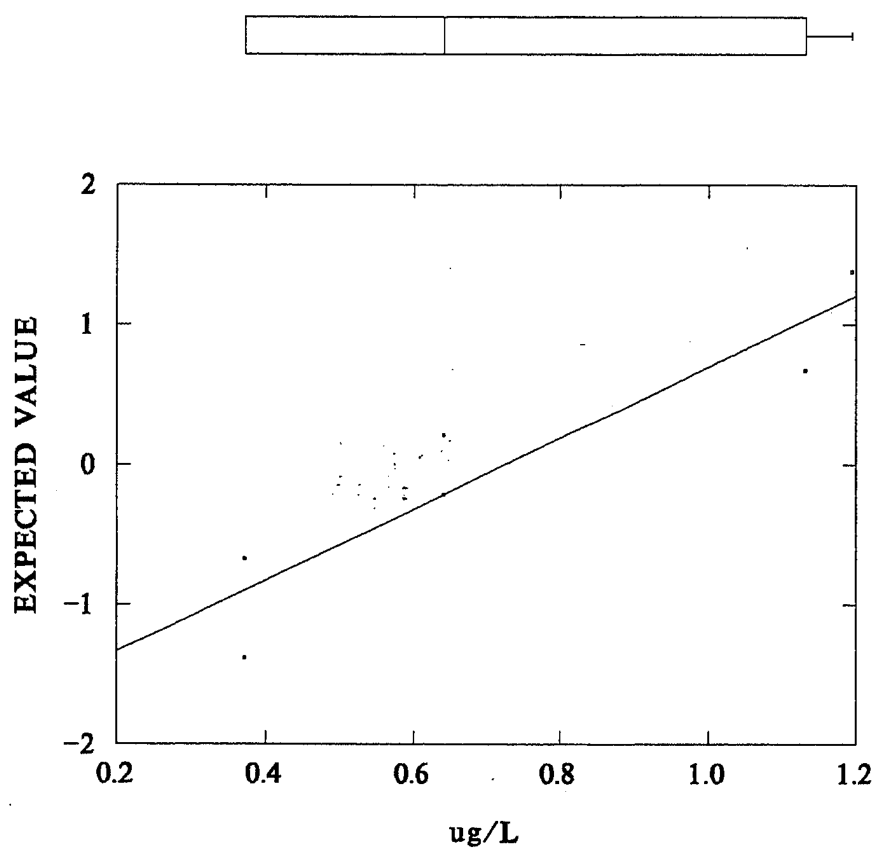
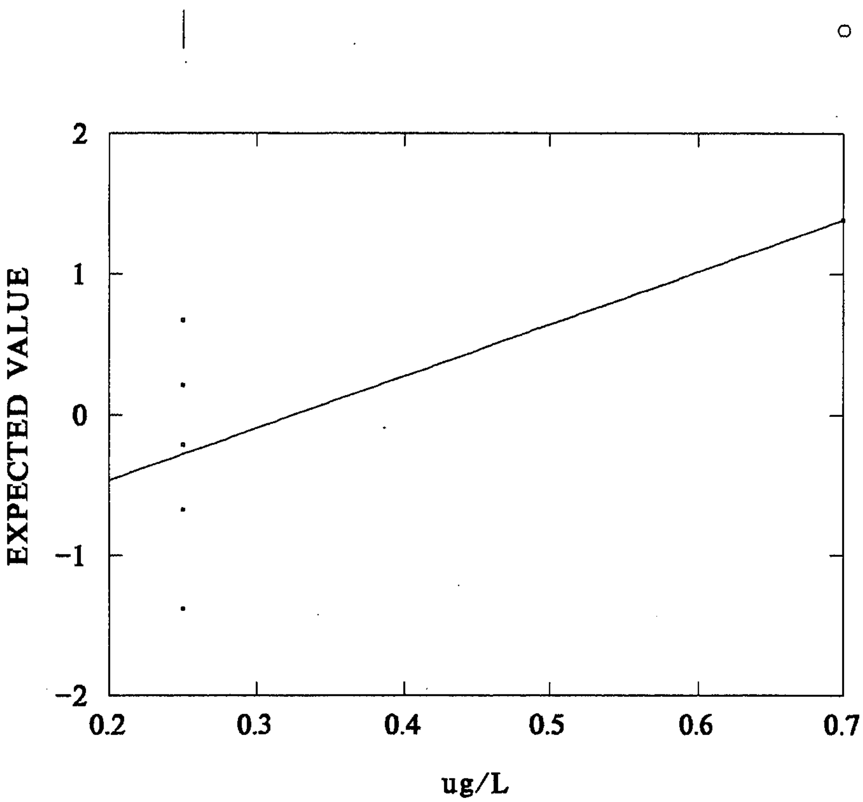


Figure M-43. Goodness-of-Fit Tests Using Probability and Box Plots: Trichloroethylene in Water (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio



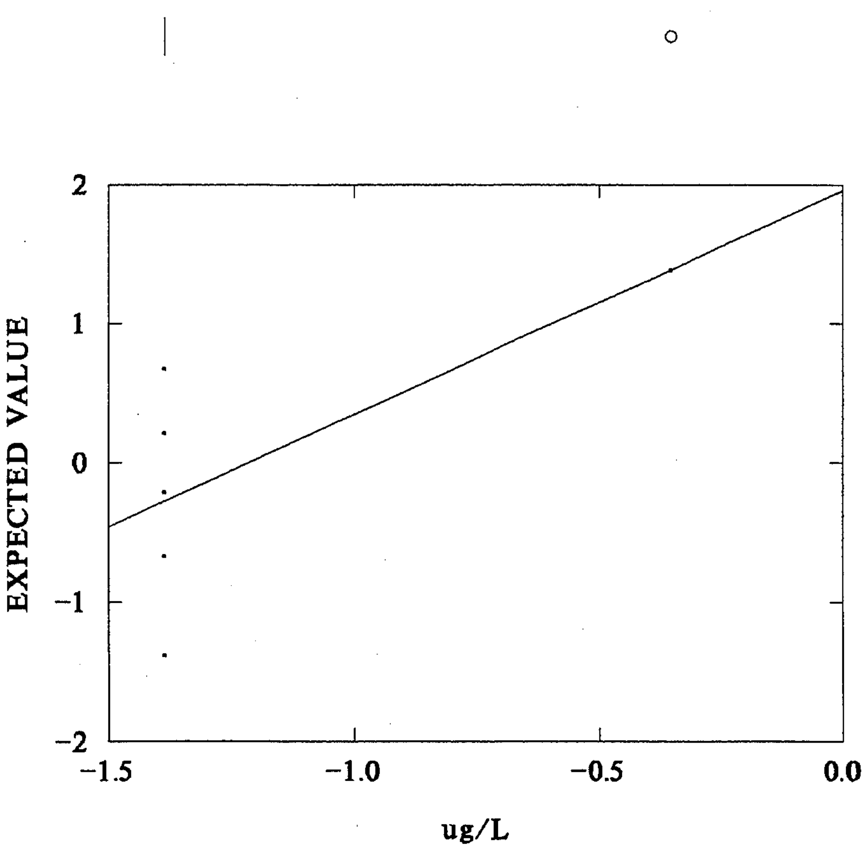


Figure M-44. Goodness-of-Fit Tests Using Probability and Box Plots: Zinc in Water (Normal and Lognormal)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio